BEFORE THE
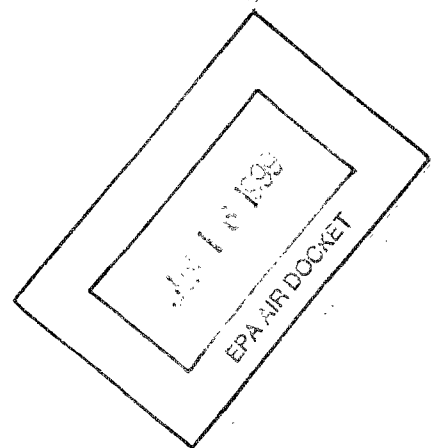# UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

PETITION OF THE
CHEMICAL MANUFACTURERS ASSOCIATION
KETONES PANEL TO REMOVE METHYL ETHYL KETONE
FROM THE LIST OF HAZARDOUS AIR POLLUTANTS
UNDER SECTION 112(b) OF THE CLEAN AIR ACT

VOLUME I OF IV

SUBMITTED BY

CHEMICAL MANUFACTURERS ASSOCIATION
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November 27, 1996

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TABLE OF REFERENCES

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APPENDIX B

EXXON CHEMICAL COMPANY MEK TECHNICAL PRODUCT BROCHURE

METHYL ETHYL KETONE

SOLVENTS

METHYL ETHYL KETONE

(MEK)

$$\underset{\displaystyle CH_3\text{-}C\text{-}CH_2CH_3}{\overset{\displaystyle O}{\overset{\displaystyle \|}{}}}$$

Methyl ethyl ketone (MEK) is a low-boiling, chemically stable compound similar in properties to acetone. Sometimes referred to as butanone, MEK is a flammable, colorless liquid prossessing a typical ketonic odor. Not quite as volatile as acetone, it is nevertheless a fast evaporator, its evaporation rate being roughly comparable to that of ethyl acetate. MEK is a good solvent for many natural and synthetic resins. It is miscible with most organic solvents. MEK is only partially miscible with water and forms a constant boiling mixture at 73.6°C (164.5°F) containing approximately 11 per cent by weight of water. The pure ketone boils at 79 6°C (175.3°F).

Specifications	Value	ASTM Test Methods
Acidity (as acetic acid). Wt %	0 003 Max	Exxon Chemical 160 34
Color. Platinum-Cobalt	10 Max	D 1209
Distillation		D 1078
Initial Boiling Point	78 5°C(173.3°F). Min.	
Dry Point	81 0°C(177.8°F). Max	
Range	1 5°C(2 7°F) including 79 6°C (175.3°F)	
Non-Volatile Matter. g/100 ml	0 002 Max.	D 1353
Odor	Characteristic. Non-residual	D 1296
Purity. by G C . Wt %	99 5 Min	D 2804
Specific Gravity 20 20°C	0 805 Min. 0 807 Max	D 268
Water Content. Wt %	0 1 Max.	D 1364

Applications as a Solvent

Surface Coatings
MEK is widely used as a component of vinyl lacquer solvent systems. Its powerful active solvency for vinyl acetate and vinyl chloride-vinyl acetate copolymers makes it possible to formulate high-solids lacquers containing large amounts of economical hydrocarbon diluents. Spray, dip, knife, brush, or roller techniques can be used to apply these lacquers at room or elevated temperatures. MEK is also used in vinyl type protective strippable coatings for equipment in storage.

MEK is a strong active solvent for nitrocellulose and is extensively used in furniture and automotive lacquers. It has good blush resistance and helps provide low viscosity at high solids concentration. MEK is of high purity and has a toluene dilution ratio of 4.3; therefore it can tolerate a high percentage of low-cost aromatic diluent without allowing the nitrocellulose to precipitate. Its low specific gravity enables formulators to produce larger volumes of base lacquers or thinners per pound of MEK than is possible with heavier solvents.

Another use for MEK is in thinner blends for acrylic and acrylic-nitrocellulose lacquers. MEK is also a solvent for alkyds and other resins often used to modify nitrocellulose lacquers. Air-dried epoxy finishes with physical properties similar to those of baked finishes are obtained with the help of MEK.

This versatile solvent is also used in surface coatings based on ethyl cellulose, cellulose acetate-butyrate, polyurethanes, and vinylidene chloride-acrylonitrile copolymer. Other uses for MEK are in fabric coatings, and synthetic rubber coatings.

In some areas, Rule-66 type air pollution regulations, which restrict the use of certain solvents, are still in force.

MEK is listed as a non-restricted solvent by Rule 66-type regulations. Therefore, it is used in the reformulation of a wide variety of coatings, inks, and adhesives to replace Rule 66-type restricted solvents. MEK is particularly useful in boosting the solvency of weaker exempt solvents which often must be employed to replace restricted solvents, such as aromatics.

Adhesives

MEK is a major solvent for adhesives. The excellent solvent properties and fast evaporation of MEK account for its wide use as a solvent in many compounded polyurethane, nitrile rubber and neoprene-based industrial cements. These include high-strength, oil-resistant, resilient adhesives; heat-activated adhesives for lamination; low-temperature and heat-activated curing cements used as general purpose adhesives; and a number of specialty cements such as those used for bonding vinyl to fabrics, and paper coating cements. MEK also goes into vinyl solution formulations used as heat-sealable, grease-resistant paper coatings and cellulose acetate laminating adhesives. This versatile solvent is also used in bonding cements for polystyrene, polyvinyl chloride, and polyvinyl chloride-polyvinyl acetate copolymers. Good shelf life is an added advantage of using MEK in adhesive formulations.

Inks

The strong solvency and fast evaporation rate of MEK make it an important component of gravure printing inks, particularly in Type C and Type V inks. It also finds some applications in silk screen printing.

Solvent Extraction

The selective solvency of MEK has promoted its use as an extraction medium for fats, oils, waxes, and resins. Another use is in the concentration of fatty acids in aqueous solutions. MEK is used in the recovery of acetic acid from dilute solutions. Pharmaceutical applications include use in the recovery and concentration of penicillin. Spent absorption agents used in the refining of oil can be reactivated by an MEK-benzene mixture. MEK is also used in a process for removing sulfur from oils. MEK does not hydrolyze to form corrosive products. This is an advantage over esters in solvent recovery systems.

Traffic Marking Paint

Millions of gallons of traffic paint are used by city, county, and state governments every year. Much of this paint is a solvent-based, oil modified, alkyd resin type. Because of the solvent portion of the formulation constituting as much as 50%, some concern about air pollution has been shown. MEK is an important component in replacing air pollution regulation restricted solvents, such as toluene, which are used in these alkyd formulations. It enhances the solvency of the weaker, exempt aliphatic hydrocarbon solvents which are often used to replace the restricted aromatics. MEK is also finding application in fast dry traffic paints formulated with chlorinated rubber.

Cleaning Fluids

Many cleaning compositions make use of the powerful solvent action of MEK. It is widely used in paint-, lacquer-, and varnish-removers. Industrial metal- and engine-cleaning solvents also incorporate MEK.

Dewaxing Agents

In mixtures with benzene or toluene, MEK is used in petroleum refineries for reducing the wax content of lubricating oils. The ketone precipitates the wax while the aromatic solvent holds the oil in solution. This process can be adapted to a great variety of lubricating oils by varying the percentage of MEK in the mixture.

Dyeing

Methyl ethyl ketone is used as a solvent for various dyes and for inks used in printing on cellulose-derivative surfaces. Anthraquinone dyes for acetate fabric are prepared in a process which uses MEK. Oil and fat are removed from wool prior to dyeing by washing in MEK.

Miscellaneous

Combined with chemicals such as mercuric oxide or with chlorinated hydrocarbons, MEK is used in insecticides, fungicides, and germicides. MEK is also used in the manufacture of smokeless powder. It is a solvent for various anti-oxidants. Photographic film, artificial leather, and many types of plastics are manufactured with the help of this excellent solvent.
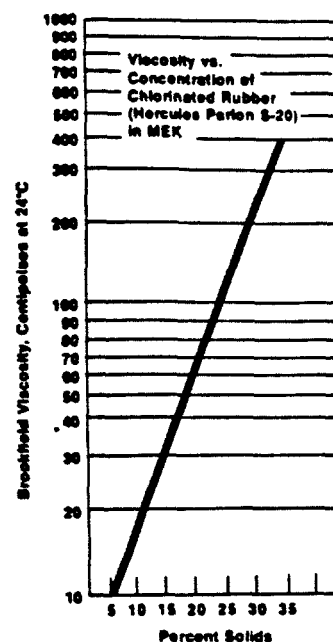
Applications as a Chemical Intermediate

Potentially, methyl ethyl ketone (MEK) can be as widely utilized as acetone for chemical synthesis. Reactivity centers around the carbonyl group and its adjacent hydrogen atoms. Condensation, ammonolysis, halogenation, and oxidation can be carried out under the proper conditions. Some typical reactions are described below.

1. Self-Condensation

Aldol condensation of two moles of MEK yields a hydroxy ketone which readily dehydrates to an unsaturated ketone.

$$2CH_3CCH_2CH_3 \longrightarrow CH_3CH_2CCH_2CCH_2CH_3 \longrightarrow$$

$$CH_3CH_2C = CHCCH_2CH_3$$

2. Condensation with Other Compounds

Reaction with aldehydes gives higher ketones, as well as ketals and cyclic compounds, depending on reaction conditions. ß-diketones are produced by the condensation of MEK with aliphatic esters. MEK condenses with glycols and organic oxides to give derivatives of dioxolane.

sec-Butylamine is formed by reacting MEK with aqueous ammonia and hydrogen.

$$CH_3CCH_2CH_3 + NH_3 + H_2 \xrightarrow{Ni}$$

$$CH_3CHCH_2CH_3 + H_2O$$
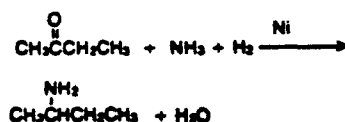
An excess of MEK in this reaction will also produce the secondary amine, di-sec-butylamine.

Reacting MEK with acetylene gives methyl pentynol, a hypnotic compound.

$$CH_3CCH_2CH_3 + HC\equiv CH \longrightarrow CH_3CH_2CC\equiv CH$$
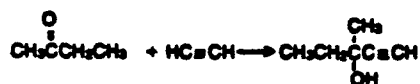
3. Miscellaneous Reactions

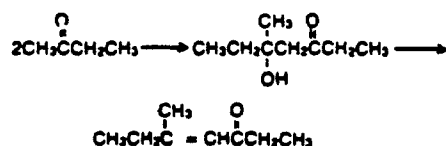Oxidation of MEK with oxygen produces diacetyl, a flavoring material. Chlorination yields mixtures of several monochloro and dichloro derivatives in percentages depending on reaction conditions. The reaction of MEK with hydrogen peroxide gives a mixture of peroxides and hydro-peroxides which is used to cure polyester resins at room temperature.

$$CH_3CCH_2CH_3 + H_2O_2 \longrightarrow CH_3CCH_2CH_3$$
$$OOH$$
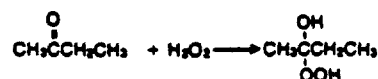
This initial addition product is the unstable precursor of seven stable peroxides and hydroperoxides. Of these, 2,2'-dihydroperoxy-2,2'-dibutyl peroxide, is

$$HOOC-OO-COOH$$
$$C_2H_5 \quad C_2H_5$$
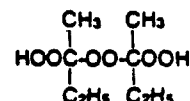
present in largest amount (about 45 per cent) in the peroxide mixture.

MEK peroxides are widely used as catalysts for the polymerization of polyester resins at room temperature. The condensation product of MEK and m-phenylene diamine is an efficient curing agent for epoxy resins. MEK and cobalt acetate function together as a specific catalyst for the single stage oxidation of p-xylene to terephthalic acid. Aliphatic monoketones, such as MEK, also function as catalysts in the polymerization of poly (ethylene terephthalate) where, it is claimed, they speed condensation times and cause less yellowing of the polymer than antimony trioxide. MEK is also used in the preparation of complex catalysts used in the syndiotactic polymerization of α-olefins such as polypropylene.

Phenol, glyoxal, formaldehyde, acetaldehyde, furfuraldehyde, and other chemicals can be made to react with MEK to form resins useful for adhesives, coatings, molded products, and electrical insulation.

MEK reacts with acrylonitrile to produce a dinitrile, which upon hydrogenation produces amines.

PROPERTIES OF THE PURE COMPOUNDS* (all values are at 20°C, except where noted)	Acetone	MEK	MIBK	Mesityl Oxide	Isophorone
Autoignition Temperature, Vapor, °F	1000	960	854	—	860
Azeotrope with Water, B.P., °C	—	73.4	87.9	91.8	99.5
Wt. % Ketone in Vapor	—	88.7	76.0	65.2	16.1
Boiling Point °F	133.0	175.3	241.2	265.6	419.4
°C	56.1	79.6	116.2	129.8	215.2
Coefficient of Cubic Expansion, per °C	0.00143	0.00119	0.00116	0.00109	0.00085
Critical Pressure, atm.	47	43	32	—	35
Critical Temperature, °C	235	260	298	—	441
Density, g/ml	0.7907	0.8037	0.8006	0.853	0.920
Dielectric Constant	21.45	18.51	13.11	15.4	—
Dilution Ratios, Toluene	4.5	4.3	3.6	3.7	6.2
Aliphatic Naphtha	0.7	0.9	1.1	0.9	1.0
Dipole Moment, Debye units	2.72 (25°C)	2.74	2.7	2.7	4.0
Electrical Conductivity, × 10^{-8} mho	5.5	5.0	—	—	—
Explosive Limits, in air, vol. %					
Upper	12.8	10.0	7.5	8.8	3.8
Lower	2.6	1.8	1.4	1.3	0.8
Flash Point, °F					
Tag Open Cup	15	34	74	98	205
Tag Closed Cup	1	28	60	83	200
Freezing Point °C	−94.7	−86.3	−80.2	−53	−8.1
°F	−138.5	−123.3	−112.4	−63	17.4
Gallons per 100 pounds	15.15	14.90	14.97	14.04	13.02
Heat of Combustion, BTU/lb.	13,260	14,540	15,980	—	15,630
Heat of Fusion, cal/g	23.4	24.7	—	—	—
Heat of Vaporization, BTU/lb. at B.P.	219.76	190.69	155.97	157	139
Molecular Weight	58.087	72.104	100.156	98.14	138.2
Pounds per gallon	6.60	6.71	6.68	7.12	7.68
Refractive Index n$_D$	1.3592	1.3791	1.3956	1.4456	1.4781
Relative Evaporation Rate (n-Butyl Acetate = 100)	1160	572	165	90	3
Solubility, Wt. %					
— of ketone in water	Infinite	26.3	1.7	3.1	1.2
— of water in ketone	Infinite	11.8	1.9	3.4	4.3
Solubility Parameter	10.0	9.3	8.4	9.2	9.7
Specific Gravity	0.7911	0.8051	0.8042	0.854	0.922
Specific Heat, BTU/lb., °F	0.528	0.549	0.459	0.520	0.426
Surface Tension, dynes/cm	23.32	24.6	23.64	22.9	32.3
Thermal Conductivity, Cal/(cm^2) (sec)(°C) × 10^6	428	356	—	—	—
Vapor Pressure, mm Hg	185.95	90.21	14.96	7.9	0.2
Viscosity, centipoise	0.32	0.43	0.58	0.6	2.6

*These are properties of pure chemical compounds, and should not be taken as specifications for commercial products.

Vapor Pressures of
Ketones *vs.* Temperature

Vapor Pressure, mm Hg (y-axis)

Temperature, °C (x-axis)

Curves labeled: ACETONE, MEK, MIBK, MESITYL OXIDE, ISOPHORONE
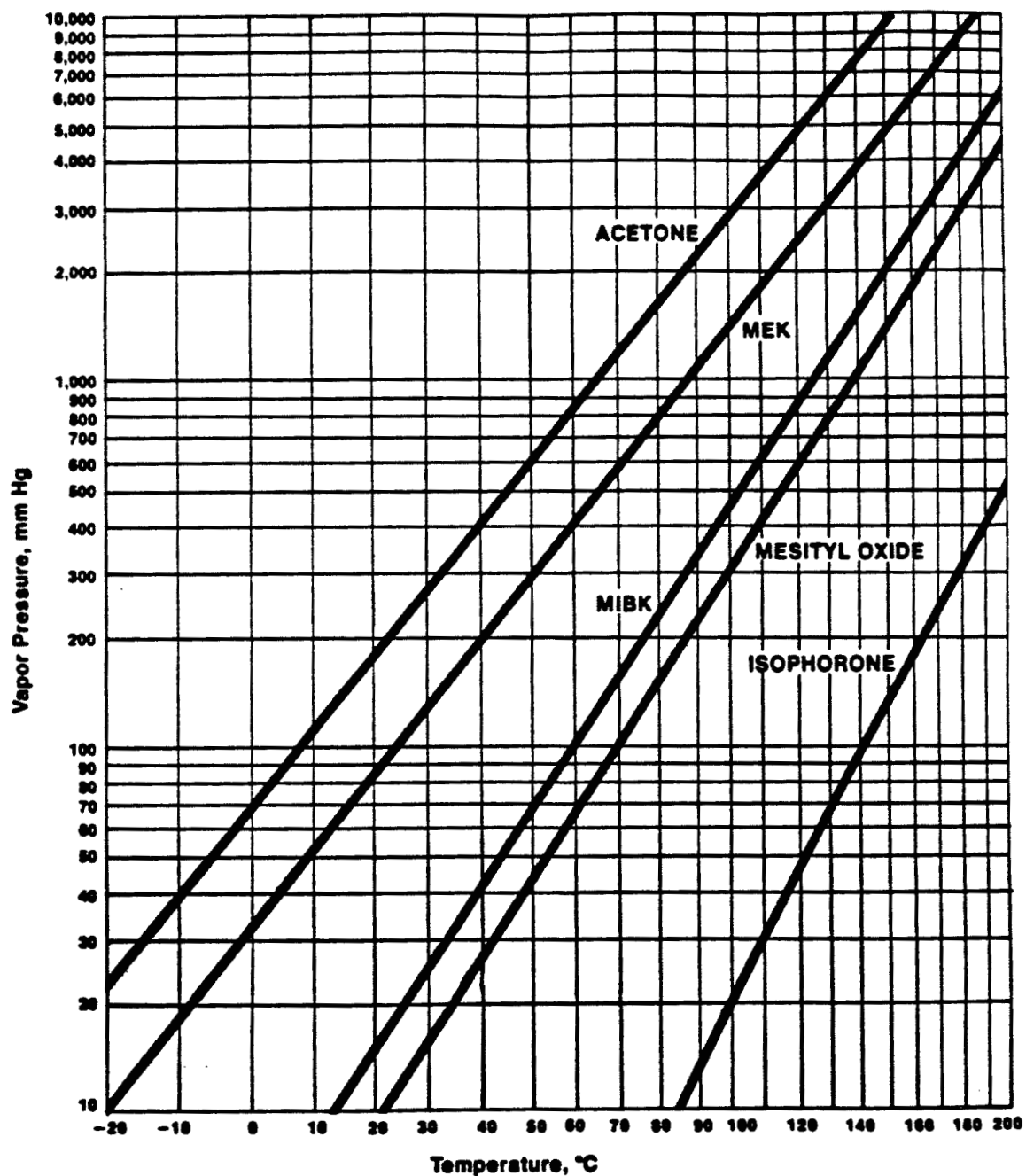
Specific Gravities of
Ketones *vs.* Temperature
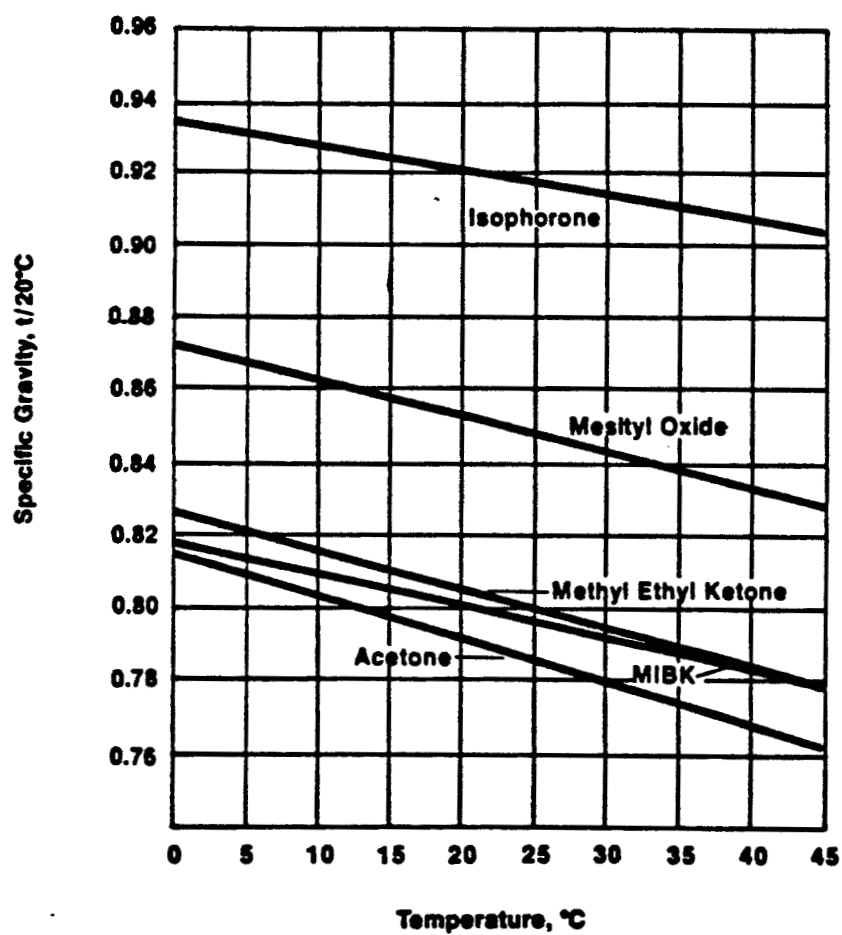
Fire and Physiological Properties of Ketones

Acetone	MEK	MIBK	Isophorone	Mesityl Oxide
Highly Flammable	Flammable		Combustible	Flammable

Ketones will ignite at ambient temperatures and can be expected to form flammable mixtures upon release to the air.

PHYSIOLOGICAL PROPERTIES

	Acetone	MEK	MIBK	Isophorone	Mesityl Oxide
EYE CONTACT	Markedly irritating	Severely irritating	Moderately irritating	Severely irritating	Severely irritating
SKIN CONTACT	Low order of toxicity. Frequent or prolonged contact may irritate skin and cause dermatitis. Avoid frequent or prolonged skin contact.				Moderate irritation. Absorbed in toxic amount on prolonged contact.
INHALATION	In high concentration, vapor is irritating to eyes and mucous membranes, and is anesthetic. Avoid breathing vapors. Keep concentration below TLV.			Negligible hazard at ambient temperature because of low volatility. Anesthetic at high concentration.	Highly irritating. Exposure to high vapor concentration results in loss of consciousness.
THRESHOLD LIMIT VALUE* (TLV), ppm in air	1000	200	50	5	15
OSHA Time Weighted Average** (TWA), ppm in air	1000	200	100	25	25
INGESTION	Low order of toxicity.				Moderately toxic

Precautions

Keep away from heat, sparks and flames.
Keep containers closed.
Do not get in eyes.
Avoid prolonged or repeated skin contact.

Avoid breathing vapors.
Keep concentration in air below Threshold Limit Value.
Note Special Precautions.

First Aid

Eye Contact
Immediately flush eyes with plenty of water for at least 15 minutes. Call a physician.

Skin Contact
Flush with water; use soap if available.

Inhalation
If overcome by vapor, remove immediately from exposure and call a physician. Administer artificial respiration if breathing is irregular or has stopped.

Ingestion
No hazard by this route in normal industrial use. Call a physician if swallowed.

Spills and Leaks
Eliminate all sources of ignition. Warn occupants of downwind areas of fire and explosion hazard. Prevent liquid from entering sewers, streams or low areas. Keep people away. Contain spilled liquid with sand or earth and recover by pumping or with a suitable absorbent. Cleanup personnel should be equipped with adequate protective equipment including chemical safety goggles, self-contained breathing apparatus and protective clothing.

Waste Disposal
Ketones may be disposed of by incineration in a manner conforming to local regulations.

Fire Fighting
Alcohol-type foam is recommended for fighting ketone liquid fires. Alternatively, dry chemical, carbon dioxide, or water fog may be used. Use water spray to cool fire-exposed containers and to protect personnel.

Storage and Handling
Ketone solvents are flammable, volatile chemicals and must be handled cautiously. Users should familiarize themselves with the Underwriters' codes for these materials, and with applicable federal, state, and local regulations.

Storage tanks should be located well away from other buildings, and away from all possible sources of ignition. Underground tanks may be necessary in some cases. Aboveground tanks should be surrounded by firebanks sufficient to contain the tanks' contents. Tanks, pipeline systems, and all other equipment should be grounded to prevent the accumulation of static electricity.

Pressure buildup in tanks should be prevented by vent lines equipped with flame arrestors. Such vent lines should not discharge near doors, windows, chimneys, or any source of heat or sparks. The pipelines used for filling and discharge should extend almost to the bottom. Centrifugal pumps can be used to draw liquid from the tank. Drip pans should be provided wherever solvents are transferred from drums or taps.

Adequate ventilation in storage and work areas is extremely important. Excess solvent vapor in the air constitutes a serious explosion and fire hazard. In addition, if the Threshold Limit Value is exceeded, discomfort to workers along with possible toxic effects may result. Publications of the National Board of Fire Underwriters contain much useful information on the design of ventilating systems.

Proper education of employees as to the dangers involved in handling volatile solvents is the cornerstone of good safety practice. Workers should be trained to recognize and correct hazardous conditions. Fire extinguishers, masks, goggles, and other safety equipment should be strategically located and workers should be taught how to use them. Men entering vats or tanks for inspection or cleaning should be provided with the proper harness and should always be observed by someone outside the entrance. Fire drills and safety inspections should be carried out regularly. Safety precautions should be suitable for the particular facilities, personnel, and operations of each plant.

Special Precautions

Ketones should not be used with certain active chlorine compounds without attention being directed to the possible formation of toxic chloroketones.

Shipping Information

	Pounds per Gallon at 20°C	Coefficient of Expansion, per °C	Flash Point TCC, °F	DOT Designation	Note
ACETONE	6.60	0.00137	0	Flammable Liquid	
METHYL ETHYL KETONE	6.71	0.00130	21	Flammable Liquid	
METHYL ISOBUTYL KETONE	6.68	0.00113	62	Flammable Liquid	
MESITYL OXIDE	7.11	0.00109	84	Flammable Liquid	May form peroxides on long storage
ISOPHORONE	7.68	0.00085	190	Combustible Liquid	Freezes at 17°F

Sales Offices

Akron
3020 W. Market Street
Akron, Ohio 44313
(216) 836-7911

Atlanta
380 Interstate North, Suite 375
Atlanta, Georgia 30339
(404) 955-2300

Chicago Area
Suite 550
701 Lee Street
Des Plaines, Illinois 60016
(312) 298-1000

Detroit Area
23625 Northwestern Highway
Southfield, Michigan 48075
(313) 355-2000

New York Area
P.O. Box 201
Florham Park, New Jersey 07932
(201) 765-0100

Houston
P.O. Box 3272
Houston, Texas 77001
(713) 870-6000

Los Angeles Area
Suite 410
5199 East Pacific Coast Highway
Long Beach, California 90804
(213) 597-1020

New Orleans
4450 General DeGaulle
Suite 1210
New Orleans, Louisiana 70114
(504) 561-3553

St. Louis Area
7777 Bonhomme Avenue, Suite 909
Clayton, Missouri 63105
(314) 726-5933

Wilmington
410 West Ninth St.
Wilmington, Delaware 19801
(302) 656-4606

EXXON CHEMICAL AMERICAS
P. O. Box 3272, Houston, TX 77001

EXXON CHEMICALS

APPENDIX C

IRIS DATABASE ENTRY FOR MEK

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1     - IRIS
IRIS NUMBER                 69
LAST REVISION DATE         930602
UPDATE HISTORY             06/02/93, 2 fields
IRIS STATUS                Oral RfD Assessment (RDO) on-line 05/01/93
IRIS STATUS                Inhalation RfC Assessment (RDI) on-line 07/01/92
IRIS STATUS                Carcinogenicity Assessment (CAR) on-line 12/01/89
IRIS STATUS                Drinking Water Health Advisories (DWHA) no data
IRIS STATUS                U.S. EPA Regulatory Actions (EXSR) on-line
                           01/01/92
IRIS REVISION HISTORY      03/31/87 RDO Documentation corrected
IRIS REVISION HISTORY      03/01/88 RDO Paragraph 2 clarified
IRIS REVISION HISTORY      07/01/89 CAR Carcinogen assessment now under
                           review
IRIS REVISION HISTORY      07/01/89 REFS Bibliography on-line
IRIS REVISION HISTORY      12/01/89 CAR Carcinogen assessment on-line
IRIS REVISION HISTORY      12/01/89 CREF Carcinogen references added
IRIS REVISION HISTORY      04/01/90 RDI Inhalation RfC now under review
IRIS REVISION HISTORY      06/01/90 RDO Oral RfD summary noted as pending
                           change
IRIS REVISION HISTORY      06/01/90 RCRA EPA contact changed
IRIS REVISION HISTORY      08/01/91 RDO Withdrawn pending further review
IRIS REVISION HISTORY      08/01/91 OREF Oral RfD references withdrawn
IRIS REVISION HISTORY      01/01/92 EXSR Regulatory Action section on-line
IRIS REVISION HISTORY      07/01/92 RDI Inhalation RfC on-line
IRIS REVISION HISTORY      07/01/92 IREF Inhalation RfC references on-line
IRIS REVISION HISTORY      08/01/92 IREF Inhalation RfC references clarified
IRIS REVISION HISTORY      10/01/92 RDO Work group review date added
IRIS REVISION HISTORY      12/01/92 RDO Work group review date added
IRIS REVISION HISTORY      05/01/93 RDO Oral RfD summary replaced; RfD
                           changed
IRIS REVISION HISTORY      05/01/93 OREF Oral RfD references replaced
IRIS REVISION HISTORY      06/01/93 CREF Minor correction
RECORD LENGTH              48433
NAME OF SUBSTANCE          Methyl ethyl ketone (MEK)
CAS REGISTRY NUMBER        78-93-3
SYNONYMS                   aethylmethylketon
SYNONYMS                   2-butanone
SYNONYMS                   butanone-2
SYNONYMS                   ethyl methyl cetone
SYNONYMS                   ethylmethylketon
SYNONYMS                   ethyl methyl ketone
SYNONYMS                   ketone, ethyl methyl
SYNONYMS                   meetco
SYNONYMS                   MEK
SYNONYMS                   methyl acetone
SYNONYMS                   Methyl Ethyl Ketone
SYNONYMS                   metiletilchetone
SYNONYMS                   metyloetyloketon
SYNONYMS                   RCRA waste number U159
SYNONYMS                   UN 1193
SYNONYMS                   UN 1232
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REFERENCE DOSE FOR ORAL EXPOSURE
o ORAL RFD SUMMARY :

Critical Effect	Experimental Doses*	UF	MF	RfD

Decreased fetal birth weight	NOAEL: 1771 mg/kg-day (1% 2-butanol solution)	3000	1	6E-1 mg/kg-day
Multigeneration/ Developmental Rat Feeding Study	LOAEL: 3122 mg/kg-day (2% 2-butanol solution)			

Cox et al., 1975

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*Conversion Factors and Assumptions: Based on actual consumption data for the NOAEL and regression analysis for the LOAEL of exposure to 2-butanol, a metabolic intermediate of methyl ethyl ketone.

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o ORAL RFD STUDIES :

Cox, G.E., D.E. Bailey and K. Morgareidge. 1975. Toxicity studies in rats with 2-butanol including growth, reproduction and teratologic observations. Food and Drug Research Laboratories, Inc., Waverly, NY, Report No. 91MR R 1673.

The identification of the critical effect for methyl ethyl ketone (MEK), also referred to as 2-butanone, is based on its metabolic intermediate, 2-butanol. A detailed rationale for use of this intermediate of MEK can be found in Additional Comments/Studies.

Weanling FDRL-Wistar stock rats (30/sex/group) were given 2-butanol in drinking water at 0, 0.3, 1.0, or 3.0% solutions and a standard laboratory ration ad libitum. Weekly feed, fluid intakes and body weights were recorded to determine the efficiency of food utilization and to calculate the average daily intake of 2-butanol. The average daily intake of 2-butanol for males was 0, 538, 1644, and 5089 mg/kg-day and for females was 0, 594, 1771, and 4571 mg/kg-day for the 0, 0.3, 1.0, and 3.0% solutions, respectively. At the highest exposure level (3.0%), net weight gain was reduced compared with controls both in males (229 g vs. 269 g in controls) and females (130 g vs. 154 g in controls) during the 8 weeks of initial monitoring. However, no differences were found in the efficiency of food utilization.

After 9 weeks of exposure, parental matings were made with one male and one female from each of the respective treatment groups (P generation). Following birth of the first litter (F1A) of the parental generation, various reproduction and lactation responses were measured. This study design incorporated a multigeneration protocol with measurement of developmental toxicity endpoints. Significant effects were noted in the litters from the 3.0% 2-butanol dose group vs. the control group, including the number of pups/litter cast alive (8.46 vs. 10.3), the number of pups/litter alive at 4 days before culling (8.12 vs. 10.3), the number of pups/litter alive at 21 days (6.85 vs. 7.68), the mean body weight/pup after culling at 4 days (8.2 g vs. 10.3 g) and the mean body weight/pup at 21 days (28.4 g vs. 49.5 g).

Based on results found in the 3.0% (high-dose) 2-butanol F1A generation, the treatment of all high-dose parents and offspring was reduced to 2.0% 2-butanol for the remainder of the experimental protocol. Following a 2-week interim adaptation period to allow the F1A generation animals to attain a more normal weight, the P generation was subsequently remated to produce a second litter (F1B), and the F1A generation selected for an F2 mating. Therefore, a new high dose of 2.0% 2-butanol was calculated to be equivalent to 3384 mg/kg-day in males and 3122 mg/kg-day in females based on regression analysis of the 8 week water intake data. The F1B litters receiving 2.0% 2-butanol showed a slight reduction in average fetal weight compared with controls (3.74 g vs.

4.14 g in controls). Nidation, early fetal deaths, and late fetal deaths were
not detectably affected. Skeletal findings also were reported for the F1B
generation. The 2.0% group showed apparent increases in missing sternebrae,
wavy ribs, and incomplete vertebrae ossification when compared with both the
0.3 and 1.0% groups. However, because of the rather high incidence in the
control group for these findings, these effects could not be determined to be
compound-related. The 2.0% group also showed a reduction in the mean body
weight per pup at day 4 following culling (9.48 g vs. 10.0 g in the control)
and in the mean body weight at 21 days (34.9 vs. 41.1 g in the control).
Although these reductions were not as great in the high dose (3.0%) F1A
generation, the percent body weight reduction in the F1B high dose (2.0%) was
doubled at 21 days (reductions of 5% at 4 days and 11% at 21 days). This
generation showed the same doubling trend in fetal weight reduction as was
reported in the F1A group exposed to 3.0% 2-butanol throughout (reductions of
21% at 4 days and 43% at 21 days).   These results are also presented in
abstract form by Gallo et al. (1977).

     At the 2.0% level of the F2 generation, there were a number of
histopathologic changes noted in the kidney of the male rats only. These
changes were characterized by nonreactive tubular degeneration in the outer
medullary zone, tubular cast formation, foci of tubular degeneration and
regeneration, microcysts in the renal papilla, glomerular fibrosis, and focal
epithelial calcification. These findings are consistent with the pattern of
early stages of alpha 2u-globulin-associated rat nephrotoxicity as set forth
by the Risk Assessment Forum (U.S. EPA, 1991). As per the Agency's guidance,
it is not appropriate to use these specie-and sex-specific renal effects to
establish a critical effect.

     Administration of 2-butanol resulted in the occurrence of developmental
effects. Decreased pup survivability and fetal weight were seen in the 3.0%
group, and in the F1 offspring (F1A and F1B, whose parents received 3.05 and
2.0% 2-butanol, respectively). The decrease in fetal weight continued to be
demonstrated in the F2 generation at the 2.0% level. Therefore, based on
these developmental toxicologic endpoints, a LOAEL of 3122 mg/kg-day (2.0%
solution) and a NOAEL of 1771 mg/kg-day (1.0% solution) are identified.
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o ORAL RFD UNCERTAINTY :

UF -- Four uncertainty factors of 10 each were applied, one to account for
interspecies extrapolation and intraspecies variability (extrapolation to
sensitive human populations); one to adjust for subchronic to chronic
extrapolation since long-term effects in the dams during the exposure period
were not reported in the principal study; one for incompleteness of the data
base, including a lack of both subchronic and chronic oral exposure studies
for MEK; and one to account for the absence of data for a second rodent specie
for either MEK or 2-butanol. As is usual practice, the application of four
full areas of uncertainty generally results in a total uncertainty factor of
3000, given the interrelationship among and overlap between the various areas
of uncertainty described above.
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o ORAL RFD MODIFYING FACTOR :

MF -- None
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o ORAL RFD COMMENTS :

     Data on toxic effects in humans or laboratory animals following oral
exposure to MEK are restricted to a limited number of acute studies. Oral
LD50 values for MEK include 5522 and 2737 mg/kg in rats (Smyth et al., 1962
and Kimura et al., 1971, respectively) and 4,044 mg/kg in mice (Tanii et al.,

1986). Single gavage doses of 15 mmol/kg MEK in corn oil (1082 mg/kg) produced no deaths or histological alterations in the livers of male Fischer 344 rats, but produced tubular necrosis in kidneys (Brown and Hewitt, 1984). Pre-administration of single gavage doses of MEK (or other ketonic solvents) enhanced the liver and kidney damage produced by a 0.5 mL/kg intraperitoneal dose of carbon tetrachloride (Brown and Hewitt, 1984). This MEK potentiation of carbon tetrachloride hepatotoxicity was also observed in similar experiments with male Sprague-Dawley rats (Dietz and Traiger, 1979).

At present there are insufficient oral exposure data of MEK from which to derive an oral RfD. Availability of oral exposure data of a metabolic intermediate of MEK, i.e., 2-butanol, was used to derive the RfD of MEK. The following is an explanation of the rationale for using the oral data of 2-butanol rather than attempting a route-to-route extrapolation of the available inhalation data for MEK.

Traiger and Bruckner (1976) have estimated that approximately 96% of an administered dose of 2-butanol is oxidized in vivo to MEK. The data from the Dietz et al. (1981) study support this estimation. Administration of 1776 mg/kg 2-butanol by gavage shows peak blood 2-butanol concentrations (0.59 mg/mL) within 2 hours; the compound is barely detectable after 16 hours. As the blood concentrations of 2-butanol fall, the peak concentrations of MEK (0.78 mg/mL) and 2,3-butanediol (0.21 mg/mL) occurred at 8 and 18 hours respectively. Ultimately, 2-butanol and MEK are metabolized through the same intermediates.

Additional metabolism of the ketone occurs by oxidation to hydroxylated intermediates such as 2,3-butanediol, all of which can be eliminated in the urine (DiVincenzo et al., 1977). DiVincenzo et al. (1976) have previously identified MEK, 2-butanol, and other oxidative metabolites of MEK in the serum of guinea pigs following administration of MEK.

A pharmacokinetic model was presented by Dietz et al. (1981) to describe the biotransformation of 2-butanol and MEK in rats when given a dose calculated to produce an equivalent calculated adjusted urinary concentration. When MEK is administered by gavage at a dose of 1690 mg/kg, the detection of the formation of 2-butanol and the oxidative metabolites corresponds to that previously reported in the guinea pig. By 18 hours post administration, MEK is barely detectable in the blood (peak concentration of 0.95 mg/mL at 4 hours), but a peak blood concentration (0.26 mg/mL) of the oxidative metabolite 2,3-butanediol can be detected. Peak blood concentrations of 2-butanol (0.033 mg/mL) occurred after 6 hours.

Although it is not known if the effects reported by Cox et al. (1975) are due to either 2-butanol directly or indirectly through another common metabolite, the weight of evidence of the available data argues for using the butanol data as a surrogate approach to the development of the RfD for MEK. It is assumed in this surrogate approach that 2-butanol is not the active metabolite causing the effects reported by Cox, given the profile of metabolism for both 2-butanol and MEK. Therefore, it is appropriate to utilize data from the oral administration of 2-butanol in order to derive an RfD for MEK in lieu of appropriate oral data for MEK.

Decreased fetal body weight was also reported in pregnant mice exposed by inhalation to 0, 398, 1010, or 3020 ppm MEK (0, 1174, 2978, or 8906 mg/cu.m, respectively, assuming 25 C and 760 mm Hg) 7 hours/day during gestational days 6-15 (Schwetz et al., 1991; Mast et al., 1989). The only maternal effect observed was a concentration-related increase in relative liver and kidney weight. The difference was statistically significant in the dams exposed to 3020 ppm MEK. The biologic significance of this increase has not been

ascertained. The decrease in fetal body weight was observed in the 3020-ppm group, however the difference was statistically significant only in the males. There was a statistically significant (p<0.05) trend with increasing concentration in the incidence of fetuses with misaligned sternebrae, but this trend was not apparent in the incidence of litters with misaligned sternebrae. Although increased incidence of fetuses and litters with malformations were observed in exposed groups compared with controls, the increases were not statistically significant. The observed fetal malformations (cleft palate, fused ribs, missing vertebrae and syndactyly) present in the exposed groups were not observed in concurrent or contemporary control groups of the same strain of mice. The Schwetz et al. (1991) study identified a NOAEL of 1126 ppm and a LOAEL of 3020 ppm for the occurrence of significant, developmental effects in mice including a decrease in fetal body weight, thereby corroborating the effects observed by Cox et al. (1975).

Sprague-Dawley rats were exposed to 0, 1126, or 2618 ppm MEK (0, 3320, or 7720 mg/cu.m, respectively, assuming 25 C and 760 mm Hg) 7 hours/day during gestational days 6-15 (Schwetz et al., 1974). The following endpoints were used to assess exposure-related effects: maternal (body weight, food intake, liver weight, SGOT levels, number of implantations/litter size) and fetal (examination for anomalies, incidence of fetal resorptions, fetal body measurements). No maternal effects or effect on the incidence of fetal resorptions were observed. A decrease in fetal body weight and crown-rump length were observed in the 1126 ppm offspring, however, these effects were not observed in the offspring of the rats exposed to 2611lenges made to a satura enzymatic detoxification mechanism. Therefore, it cannot be assumed that the pulmonary retention value will be the same at exposures of less than 180 ppm or at greater than 1800 ppm. For this reason, it is inappropriate to estimate the pulmonary retention value at these effect levels, thereby precluding derivation of an oral RfD based upon extrapolation from inhalation effects.

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o ORAL RFD CONFIDENCE :

Study -- Low
Data Base -- Low
RfD -- Low

Confidence in the principal study is low. The multigeneration/ developmental study for 2-butanol defined a critical effect that is corroborated by inhalation exposure data. Although the study employed an adequate number of animals and examined appropriate endpoints, lowering the high-dose group from 3.0 to 2.0% confounded determination of the critical effect. Confidence in the data base is low. This RfD is based on a K in a shor developmental effects as seen by inhalation exposure to MEK. However, the lack of oral data for MEK itself and the absence of data in a second specie precludes any higher level for data base confidence. This assessment for MEK is based upon the strength of data supporting the use of the 2-butanol multigeneration study and the concurrence of developmental effects for inhalation exposure to MEK and assumes that 2-butanol was not responsible for the fetal toxicity. There is a lack of data on the metabolism of 2-roach. Ther
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o ORAL RFD SOURCE DOCUMENT :

Source Document -- This risk assessment is not presented in any existing U.S. EPA document.

Other EPA Documentation -- U.S. EPA, 1984, 1985
----
o REVIEW DATES   : 06/24/85, 07/08/85, 05/16/90, 07/17/91,
                                     09/23/92, 11/05/92

o VERIFICATION DATE   : 11/05/92
o EPA CONTACTS :

Kenneth A. Poirier / OHEA -- (513)569-7553

Harlal Choudhury / OHEA -- (513)569-7536

REFERENCE DOSE FOR INHALATION EXPOSURE
o INHALATION RFD SUMMARY :

Critical Effect	Exposures*	UF	MF	RfC
Decreased fetal birth weight	NOAEL: 2978 mg/cu.m (1010 ppm, nominal)	1000	3	1E+0 mg/cu.m
	NOAEL(ADJ): 2978 mg/cu.m			
Mouse Developmental Study	NOAEL(HEC): 2978 mg/cu.m			
	LOAEL: 8906 mg/cu.m			
Schwetz et al., 1991;	(3020 ppm, nominal)			
Mast et al., 1989	LOAEL(ADJ): 8906 mg/cu.m			
	LOAEL(HEC): 8906 mg/cu.m			

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*Conversion Factors: MW = 72.1 Assuming 25 C and 760 mm Hg. NOAEL (mg/cu.m) =
1010 ppm x 72.1/24.45 = 2978 mg/cu.m. Currently, the approach for dose-
response analysis of developmental endpoints does not duration-adjust exposure
concentrations. NOAEL(ADJ) = NOAEL = 2978 mg/cu.m. The NOAEL(HEC) was
calculated for a gas:extrarespiratory effect assuming periodicity was
attained. Since the b:a lambda values are unknown for the experimental animal
species (a) and human (h), a default value of 1.0 is used for this ratio.
NOAEL(HEC) = NOAEL(ADJ) x (b:a lambda(a)/b:a lambda(h)) = 2978 mg/cu.m.
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o INHALATION RFD STUDIES :

Schwetz, B.A., T.J. Mast, R.J. Weigel, J.A. Dill and R.E. Morrissey. 1991.
Developmental toxicity of inhaled methyl ethyl ketone in mice. Fund. Appl.
Toxicol. 16: 742-748.

Mast, T.J., J.A. Dill, J.J. Evanoff, R.L. Rommereim, R.J. Weigel and R.B.
Westerberg. 1989. Inhalation developmental toxicology studies: Teratology
study of methyl ethyl ketone in mice. Final Report. Prepared by Pacific
Northwest Laboratory, Battelle Memorial Institute, for the National Toxicology
Program, Washington, DC. PNL-6833 UC-408.

     Pregnant Swiss mice were exposed to 0, 398, 1010 or 3020 ppm methyl ethyl
ketone (0, 1174, 2978 or 8906 mg/cu.m, respectively, assuming 25 C and 760 mm
Hg) 7 hours/day during gestational days 6-15. The Schwetz et al. (1991) and
the Mast et al. (1989) reports are the same developmental mouse study
presented in different formats and are hence considered as one single study.
The number of dams exposed to methyl ethyl ketone ranged from 23-28 mice
depending upon exposure group. The dams were killed on gestational day 18.
The only maternal effect observed was a concentration-related increase in
relative liver and kidney weight. The difference was statistically
significant only in the dams exposed to 3020 ppm methyl ethyl ketone. The
biological significance of this increase has not been ascertained. A decrease
in fetal body weight was also observed in the 3020 ppm exposed group; however,
the difference was significant only in the males. There was a significant

(p<0.05) trend in the incidence of misaligned sternebrae present in fetuses but not reflected in a similar analysis of litters of the animals exposed to 3020 ppm. Additionally, although no significant increase of any single malformation was found, there were several malformations (cleft palate, fused ribs, missing vertebrae and syndactyly) present at low incidences in exposed groups.

Neither maternal nor developmental toxicity was observed at exposures at or less than 1010 ppm (2978 mg/cu.m). At 3020 ppm (8906 mg/cu.m), an equivocal maternal effect was reported; however, mild developmental effects (decreased fetal body weight and misaligned sternebrae) were found. Based on the absence of both maternal and developmental toxic effects, a NOAEL of 1126 ppm (HEC=2978 mg/cu.m) is established. The LOAEL is established at 3020 ppm (HEC=8906 mg/cu.m) based on the appearance of mild, but significant developmental effects.

Groups of 21-23 pregnant Sprague-Dawley rats were exposed to 0, 1126 or 2618 ppm methyl ethyl ketone (0, 3320 or 7720 mg/cu.m, respectively, assuming 25 C and 760 mm Hg) 7 hours/day during gestational days 6-15 (Schwetz et al., 1974). The following endpoints were used to assess exposure-related effects: maternal body weight, food intake, liver weight, SGOT levels, and number of implantations/litter size; and fetal anomalies, incidence of resorptions, and fetal body measurements.

No maternal effects or effects on the incidence of fetal resorptions were observed. A decrease in fetal body weight and crown-to-rump length was observed in the offspring exposed to 1126 ppm; however, these effects were not observed in the offspring of the rats exposed to 2618 ppm There were no gross, soft tissue or specific skeletal anomalies that occurred at a significantly increased incidence among litters of dams exposed to 1126 ppm methyl ethyl ketone. However, the total number of litters containing fetuses with anomalous skeletons was increased significantly compared to controls. In the fetuses exposed to 2618 ppm methyl ethyl ketone, there was a significantly increased number of fetuses and litters having gross anomalies (two acaudate fetuses with an imperforate anus and two brachygnathous fetuses) compared to the incidence among controls. No single soft tissue anomaly occurred at a statistically significant increased incidence, but the total number of litters containing fetuses with soft tissue anomalies was significantly greater than in controls.

The study by Deacon et al. (1981) was conducted to determine the repeatability of the fetotoxic effects observed in the Schwetz et al. (1974) study. Groups of 25 pregnant Sprague-Dawley rats were exposed to 0, 412, 1002 or 3005 ppm methyl ethyl ketone (0, 1215, 2955 or 8861 mg/cu.m, respectively, assuming 25 C and 760 mm Hg) 7 hours/day during gestational days 6-15. Decreased maternal body weight gain and increased water consumption were observed in the group exposed to 3005 ppm. No other maternal effects were noted. No statistically significant differences in the incidence of external or soft-tissue alterations were observed among exposed fetuses. A significant decrease in the incidence of delayed ossification of interparietal bones of the skull and an increase in the incidence of extra lumbar ribs and in the occurrence of delayed ossification of cervical centra were noted at the 3005 ppm exposure level.

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o INHALATION RFD UNCERTAINTY :

UF -- An uncertainty factor of 1000 reflects factors of 10 to account for interspecies extrapolation, sensitive individuals, and incomplete data base including a lack of chronic and reproductive toxicity studies.
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o INHALATION RFD MODIFYING :

MF -- A modifying factor of 3 was used to address the lack of unequivocal data for respiratory tract (portal-of-entry) effects.
    FACTOR
----
o INHALATION RFD COMMENTS :

    Slight nose and throat irritation was observed in 10 human volunteers exposed to 100 ppm methyl ethyl ketone (HEC=295 mg/cu.m) for 5 minutes. Exposure to 300 ppm (HEC=885 mg/cu.m) was judged to be intolerable by the subjects (Nelson et al., 1943).

    Male andters were
measured for a single exposure concentration. Similarly, 15 guinea pigs were exposed to methyl ethyl ketone at the same concentration as were the rats. No adverse effects were reported for the exposed guinea pigs. However, this information is only presented qualitatively in the report. Furthermore, it was reported that the guinea pigs experienced a vitamin deficiency possibly contributing to two deaths during the exposure period.

    Male Wistar rats (8/group) were exposed to 0 or 200 ppm methyl ethyl ketone (0 or 590 mg/cu.m, assuming 25 C and 760 mm Hg) 12 hours/day, 7 days/week for 24 weeks. A slight increase in motor nerve conduction velocity and mixed nerve conduction velocity and a decrease in distal motor latency were observed at 4 weeks of exposure. However, no difference was observed after 4 weeks [NOEL(HEC)=295 mg/cu.m] (Takeuchi et al., 1983).

    Groups of 12 Sprague-Dawley rats were continuously exposed to 1125 ppm methyl ethyl ketone (3318 mg/cu.m, assuming 25 C and 760 mm Hg) for 16-55 days. Paicted by peripheral neurotoxins such as n-hexane. Results from other functional-deficit studies in humans (Dick et al., 1988) have been negative and in baboons (Geller et al., 1979), inconclusive, perhaps due to experimental design problems. At present, there is no convincing experimental evidence that methyl ethyl ketone, by itself, is neurotoxic to either experimental animals or humans other than possibly inducing CNS depression at high exposure levels. the data base is low. There are no multigenerational studies and only one subchronic study. Furthermore, these studies do not adequately address portal-of-entry effects given that short-term exposure to higher concentrations than that established for the LOAEL cause nasal and throat irritation in both human and experimental animal species. Reflecting medium confidence in the principal study and low confidence in the data base, confidence in the RfC is low.

o INHALATION RFD SOURCE :

Source Document -- This is not presented in any existing U.S. EPA document

Other EPA Documentation -- None
    DOCUMENT
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o REVIEW DATES   : 04/21/88, 05/26/88, 03/22/90, 05/16/90,
                                   07/17/91
o VERIFICATION DATE   : 07/17/91
o EPA CONTACTS :

Kenneth A. Poirier / OHEA -- (513)569-7553

EVIDENCE FOR HUMAN CARCINOGENICITY
o CLASSIFICATION   : D; not classifiable as to human
                                       carcinogenicity
o BASIS FOR CLASSIFICATION   : Based on no human carcinogenicity data and
                                       inadequate animal data.
o HUMAN CARCINOGENICITY DATA :

     None.
----
o ANIMAL CARCINOGENICITY DATA :

     Inadequate. No data were available to assess the carcinogenic potential
of methyl ethyl ketone by the oral or inhalation routes. In a skin
carcinogenesis study, two groups of 10 male C3H/He mice received dermal
applications of 50 mg of a solution containing 25 or 29% methyl ethyl ketone
in 70% dodecylbenzene twice a week for 1 year. No skin tumors developed in
the group of mice treated with 25% methyl ethyl ketone. After 27 weeks, a
single skin tumor developed in 1 of 10 mice receiving 29% methyl ethyl ketone
(Horton et al., 1965).
----
o SUPPORTING DATA :

     Methyl ethyl ketone was not mutagenic for Salmonella typhimurium strains
TA98, TA100, TA1535, or TA1537 with or without rat hepatic homogenates (Florin
et al., 1980; Douglas et al., 1980). Methyl ethyl ketone induced aneuploidy
in the diploid D61, M strain of Saccharomyces cerevisiae (Zimmermann et al.,
1985). Low levels of methyl ethyl ketone combined with low levels of
nocodazole (another inducer of aneuploidy), also produced significantly
elevated levels of aneuploidy in the system (Mayer and Goin, 1987).

CARCINOGENICITY ASSESSMENT DOCUMENTATION AND REVIEW
o CARCINOGENICITY SOURCE :

U.S. EPA. 1985. Health and Environmental Effects Profile for Methyl Ethyl
Ketone. Prepared by the Office of Health and Environmental Assessment,
Environmental Criteria and Assessment Office, Cincinnati, OH for the Office of
Solid Waste and Emergency Response, Washington, DC.

U.S. EPA. 1988. Updated Health Effects Assessment for Methyl Ethyl Ketone.
Prepared by the Office of Health and Environmental Assessment, Environmental
Criteria and Assessment Office, Cincinnati, OH for the Office of Solid Waste
and Emergency Response, Washington, DC.

     The 1988 Updated Health Effects Assessment for Methyl Ethyl Ketone has
received Agency review.
     DOCUMENT
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o REVIEW DATES   : 05/30/89
o VERIFICATION DATE   : 05/30/89
o EPA CONTACTS :

Dharm V. Singh / OHEA -- (202)260-5958

REPORTABLE QUANTITIES

Value (status) -- 5000 pounds (Final, 1985)

Considers technological or economic feasibility? -- NO

Discussion -- The final 5000-pound RQ takes into consideration the natural
biodegradation of this hazardous substance. The lowest primary criteria RQ
for methyl ethyl ketone (1000, pounds based on chronic toxicity and
ignitability/reactivity) has been adjusted upward one RQ level.

Reference -- 50 FR 13456 (04/04/85); 54 FR 33418 (08/14/89)

EPA Contact -- RCRA/Superfund Hotline
(800)424-9346 / (202)260-3000 / FTS 260-3000

RCRA REQUIREMENTS

Status -- Listed

Reference -- 52 FR 25942 (07/09/87)

EPA Contact --   RCRA/Superfund Hotline
(800)424-9346 / (202)260-3000 / FTS 260-3000

TOXIC SUBSTANCES CONTROL ACT REQUIREMENTS

No data available

ORAL REFERENCE DOSE REFERENCES	Brown, E.M. and W.R. Hewitt. 1984. Dose-response relationships in ketone- induced potentiation of chloroform hepato- and nephrotoxicity. Toxicol. Appl. Pharmacol. 76: 437-453.
ORAL REFERENCE DOSE REFERENCES	Cox, G.E., D.E. Bailey and K. Morgareidge. 1975. Toxicity studies in rats with 2-butanol including growth, reproduction and teratologic observations. Food and Drug Research Laboratories, Inc., Waverly, NY, Report No. 91MR R 1673.
ORAL REFERENCE DOSE REFERENCES	Deacon, M.M., M.D. Pilny, J.A. John et al. 1981. Embryo- and fetotoxicity of inhaled methyl ethyl ketone in rats. Toxicol. Appl. Pharmacol. 59: 620-622.
ORAL REFERENCE DOSE REFERENCES	Dietz, F.K. and G.J. Traiger. 1979. Potentiation of CCl4 of hepatotoxicity in rats by a metabolite of 2-butanone: 2,3-butanediol. Toxicology. 14: 209- 215.
ORAL REFERENCE DOSE REFERENCES	Dietz, F.K., M. Rodriguez-Giaxola, G.J. Traiger, V.J. Stella and K.J. Himmelstein. 1981. Pharmacokinetics of 2-butanol and its metabolites

in the rat. J. Pharmacokin. Biopharmacol. 9(5): 553-576.

ORAL REFERENCE DOSE REFERENCES

DiVincenzo, G.D., C.J. Kaplan and J. Dedinas. 1976. Characterization of the metabolites of methyl n-butyl ketone, methyl iso-butyl ketone and methyl ethyl ketone in guinea pig serum and their clearance. Toxicol. Appl. Pharmacol. 36: 511-522.

ORAL REFERENCE DOSE REFERENCES

DiVincenzo, G.D., M.L. Hamilton, C.J. Kaplan and J. Dedinas. 1977. Metabolic fate and disposition of 14C-labeled methyl n-butyl ketone in the rat. Toxicol. Appl. Pharmacol. 41: 547-560.

ORAL REFERENCE DOSE REFERENCES

Gallo, M.A., B.L. Oser, G.E. Cox and D.E. Bailey. 1977. Studies on the long- term toxicity of 2-butanol. Toxicol. Appl. Pharmacol. 41: 135. (Abstract)

ORAL REFERENCE DOSE REFERENCES

Kessler, W., B. Denk and J.G. Filser. 1988. Species-specific inhalation pharmacokinetics of 2-nitropropane. In: Biologically Based Methods for Cancer Risk Assessment, Series 159, C.C. Travis, Ed. NATO Advanced Science Institute. p. 123-1xicol. 452-464.

ORAL REFERENCE DOSE REFERENCES

Schwetz, B.A., T.J. Mast, R.J. Weigel, J.A. Dill and R.E. Morrissey. 1991. Developmental toxicity of inhaled methyl ethyl ketone in Swiss mice. Fund. Appl. Toxicol. 16: 742-748.

ORAL REFERENCE DOSE REFERENCES

Smyth, H.F., Jr., C.P. Carpenter, C.S. Weil, U.C. Pozzani and J.A. Striegel. 1962. Range-finding toxicity data: list VI. Am. Ind. Hyg. J. March-April: 95-107.

ORAL REFERENCE DOSE REFERENCES

Tanii, H., H. Tsuji and K. Hashiomoto. 1986. Structure-toxicity relationship of monoketones. Toxicol. Lett. 30: 13-17.

ORAL REFERENCE DOSE REFERENCES

Traiger, G.J. and J.V. Bruckner. 1976. The participation of 2-butanone in 2- butanol-induced potentiation of carbon tetrachloride hepatotoxicity. J. Pharmacol. Exp. Ther. 196: 493-500.

ORAL REFERENCE DOSE REFERENCES

U.S. EPA. 1984. Health Assessment Document for Methyl Ethyl Ketone. Prepared by the Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH for the Office of Solid Waste and Emergency Response, Washington, DC. (Final Draft)

ORAL REFERENCE DOSE REFERENCES

U.S. EPA. 1985. Health and Environmental Effects Profile for Methyl Ethyl Ketone. Prepared by the Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH for the Office of Solid Waste and Emergency Response, Washington, DC.

ORAL REFERENCE DOSE REFERENCES

U.S. EPA. 1991. Alpha 2u-globulin: Association with chemically induced renal toxicity and neoplasia in the male rat. Risk Assessment Forum. Washington, DC. EPA/625/3-91/019F.

INHALATION REFERENCE DOSE REFERENCES

Altenkirch, H., G. Stoltenburg and H.M. Wagner. 1978. Experimental studies on hydrocarbon neuropathies induced by methyl-ethyl-ketone (MEK). J. Neurol. 219: 159-170.

INHALATION REFERENCE DOSE REFERENCES

Broderson, J.R., J.R. Lindsey and J.E. Crawford. 1976. The role of environmental ammonia in respiratory mycoplasmosis in rats. Am. J. Pathol.

	85: 115-130.
INHALATION REFERENCE DOSE REFERENCES	Cavender, F.L., H.W. Casey, H. Salem, J.A. Swenberg and E.J. Gralla. 1983. A 90-day vapor inhalation toxicity study of methyl ethyl ketone. Fund. Appl. Toxicol. 3(4): 264-270.
INHALATION REFERENCE DOSE REFERENCES	Deacon, M.M., M.D. Pilny, J.A. John, et al. 1981. Embryo- and fetotoxicity of inhaled methyl ethyl ketone in rats. Toxicol. Appl. Pharmacol. 59: 620-622.
INHALATION REFERENCE DOSE REFERENCES	DeCeaurriz, J., J.P. Desiles, P. Bonnet, B. Marignac, J. Muller and J.P. Guenier. 1983. Concentration-dependent behavioral changes in mice following short-term inhalation exposure to various industrial solvents. Toxicol. Appl. Pharmacol. 67: 383-389.
INHALATION REFERENCE DOSE REFERENCES	Dick, R.B., W.D. Brown, J.V. Setzer, B.J. Taylor and R. Shukla. 1988. Effects of short duration exposures to acetone and methyl ethyl ketone. Toxicol. Lett. 43: 31-49.
INHALATION REFERENCE DOSE REFERENCES	Geller, I., E. Gause, H. Kaplan and R.J. Hartmann. 1979. Effects of acetone, methyl ethyl ketone and methyl isobutyl ketone on a match-to-sample task in the baboon. Pharmacol. Biochem. Behav. 11: 401-406.
INHALATION REFERENCE DOSE REFERENCES	LaBelle, C.W. and H. Brieger. 1955. The vapor toxicity of a composite solvent and its principal components. Am. Med. Assoc. Arch. Ind. Health. 12: 623-627.
INHALATION REFERENCE DOSE REFERENCES	Mast, T.J., J.A. Dill, J.J. Evanoff, R.L. Rommereim, R.J. Weigel and R.B. Westerberg. 1989. Inhalation developmental toxicology studies: Teratology study of methyl ethyl ketone in mice. Final Report. Prepared by Pacific Northwest Laboratory, Battelle Memorial Institute, for the National Toxicology Program, Washington, DC. PNL-6833 UC-408.
INHALATION REFERENCE DOSE REFERENCES	Nelson, K.W., J.F. Ege, M. Ross, L.E. Woodman and L. Silverman. 1943. Sensory response to certain industrial solvent vapors. J. Ind. Hyg. Toxicol. 25: 282-285.
INHALATION REFERENCE DOSE REFERENCES	Patty, F.A., H.H. Schrenk and W.P. Yant. 1935. Acute response of guinea pigs to vapors of some new commercial organic compounds. U.S. Public Health Reports. 50: 1217-1228.
INHALATION REFERENCE DOSE	Saida, Kh and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH for the Office of Solid Waste and Emergency Response, Washington, DC.
CARCINOGENICITY ASSESSMENT REFERENCES	U.S. EPA. 1988. Updated Health Effects Assessment for Methyl Ethyl Ketone. Prepared by the Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH for the Office of Solid Waste and Emergency Response, Washington, DC.
CARCINOGENICITY ASSESSMENT REFERENCES	Zimmermann, F.K., V.M. Mayer, I. Scheel and M.A. Resnick. 1985. Acetone, methyl ethyl ketone, ethyl acetate, acetonitrile and other polar aprotic solvents are strong inducers of aneuploidy in Saccharomyces cerevisiae. Mutat. Res. 149(3): 339-351.

HEALTH ADVISORY   None
  REFERENCES

[IRIS] SS 2 /cf?
USER:

APPENDIX D

1988 EPA MEMORANDUM FROM
J.V. NABHOLZ TO CHEMICAL REVIEW AND EVALUATION BRANCH

NOV 2 1988

MEMORANDUM

SUBJECT: Review of Delisting Petition for Methyl Ethyl Ketone
(MEK)

FROM: J. Vincent Nabholz, Ph.D.
Senior Biologist
Environmental Effects Branch
Health and Environmental
Review Division (TS-796)

TO: Elbert Dage, M. Engr.
Technical Integrater
Chemical Review and Evaluation Branch
Health and Environmental
Review Division (TS-796)

THRU: James H. Gilford, Ph.D.
Chief
Environmental Effects Branch
Health and Environmental
Review Division (TS-796)

SUMMARY

Methyl ethyl ketone is a neutral organic chemical used as a
solvent; has low bioconcentration potential; rapidly
evaporates from water and soil; moderately biodegrades under
aerobic conditions in aquatic environments, but is more
persistent in aerobic soils; and shows low toxicity to fish,
aquatic invertebrates, and green algae. Mammalian and avian
acute and chronic toxicity are also expected to be low based on
test data for laboratory mammals submitted with the petition.

SUPPORT

1. Physical/chemical parameters (attributes not referenced
were found in the petition) for methyl ethyl ketone are:

CAS#78-93-3;
Chemical formula: C4 H8 O;
MW = 72.11;
Liquid;
SH2O = 353 g/L @ 10 C;
268 g/L @ 20 C (USEPA 1984);

1

5. Measured toxicity values support the SAR analysis:

Fish acute toxicity values (LC50) = 560 to 10,000 mg/L;
Invertebrate acute values (LC50) = 520 to 8890 mg/L; and
Algal toxicity values >500 mg/L (as reported in petition);

USEPA (1985) reported 8-d NECs of 120 mg/L for cyanobacteria and 4300 mg/L for freshwater green algae;

Dojlido (1979) reported an 7-d NOEC of 806 mg/L for the freshwater green alga, Chlorella;

Brooke et al. (1984) reported a 96-h LC50 for fathead minnow of 3220. mg/L (flow-through method and measured concentrations); and

Dojlido (1979) reported a guppy 24-h LC50 of 5700. mg/L.

6. Methyl ethyl ketone are not expected to be toxic to wild mammals and birds. The following toxicity information was cited in the petition:

small mammal acute inhalation LC50 values from >5000 to 33,000 ppm;

rat subchronic (90-d) inhalation NOEL = 1,250 ppm;

rat acute oral LD50 values from 2.5 to 5.6 g/kg;

rabbit acute dermal LD50 values form 6.4 to 8.0 g/kg; and

rat developmental toxicity (inhalation) NOEL = 1,000 ppm.

7. Methyl ethyl ketone is not expected to be toxic to terrestrial plants. Chemically, this compound is a neutral organic solvent and is expected to have very low potency with respect to plant herbicidal activity.

8. Comparison of information for methyl ethyl ketone to Toxic Emissions Listing Criteria: Sufficient For Listing (Table 1, Clement Associates 1986) and Toxic Emissions Listing Criteria: May Be Sufficient For Listing (Table 2, Clement Associates 1986):

None of the criteria in Tables 1 or 2 for: toxicity only; toxicity and persistence; or toxicity and bioconcentration were met for the aquatic environment. However, no information about avian toxicity was available and mammalian information was used.

However, for the terrestrial environment, MEK may have a half-life of >14 days in aerobic soil, but acute and chronic toxicity values to terrestrial plants and animals are expected to be low.

3

APPENDIX E

TABLE SUMMARIZING ACUTE TOXICITY OF MEK TO AQUATIC ORGANISMS

Acute Toxicity of MEK to Aquatic Organisms

CLASS: COMMON NAME	SCIENTIFIC NAME	END POINT	DURATION (HOURS)	EXPOSURE TYPE	CONCENTRATION (mg/L)	REFERENCE
FRESHWATER FISH						
Fathead Minnow	*Pimephales promelas*	LC_{50} [1]	96	Flow-through	3220	Brooke et al. 1984
Bluegill Sunfish	*Lepomis macrochirus*	LC_{50}	48	Static	5640 [4]	Turnbull et al. 1954
SALTWATER FISH						
Sheepshead Minnow	*Cyprinodon variegatus*	LC_0 [2]	96	Static	400 [4]	Heitmuller et al. 1981
FRESHWATER INVERTEBRATE						
Water Flea	*Daphnia magna*	EC_{50}IM [3]	48	Static	5091 [4]	Randall and Knopp 1980
MARINE INVERTEBRATE						
Brine Shrimp	*Artemia salina*	LC_{50}	24	Static	1950 [4]	Price et al. 1974

Notes:
(1) Concentration lethal to 50% of the test population.
(2) Concentration at which the test population is not affected; this was the highest concentration tested.
(3) Concentration at which 50% of the test population is immobilized.
(4) Concentration not analytically verified.

APPENDIX F

**TABLE OF AMBIENT AIR CONCENTRATION
LEVELS OF MEK (TAKEN FROM A STUDY CONDUCTED BY THE STATE
OF NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION IN 1978)**

TABLE OF AMBIENT AIR CONCENTRATION LEVELS OF MEK
(TAKEN FROM A STUDY CONDUCTED
BY THE STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECTION
IN 1978)

TABLE II - 5

SUMMARY OF SELECTED VOLATILE ORGANIC SUBSTANCE CONCENTRATIONS IN NEW JERSEY, 1979

	MIDDLESEX					NEWARK				
	All Samples			Quantifiable Samples		All Samples			Quantifiable Samples	
	# of Samples	Avg Conc	Range	# of Samples	Avg Conc	# of Samples	Avg Conc	Range	# of Samples	Avg Conc
Chloroform	46	0.00	0-0.01	0	-	50	0.00	0-0.01	0	-
Carbon tetrachloride	46	0.03	0-0.10	0	-	50	0.02	0-0.10	0	-
1,2-Dichloroethane	46	0.01	0-0.59	1	0.59	50	0.00	0-0.01	0	-
1,1,2-Trichloroethane	46	0.00	0-0.01	0	-	50	0.00	0-0.01	0	-
1,2-Dibromoethane	37	0.24	0-3.5	8	1.08	41	0.10	0-1.2	8	0.55
1,1,2,2-Tetrachloroethane	46	0.06	0-2.3	2	1.36	50	0.06	0-2.0	2	1.42
Vinyl chloride	13	0.03	0-0.32	2	0.19	15	0.04	0-0.57	1	0.57
Trichloroethylene	46	1.15	0-8.6	28	1.89	50	0.25	0-1.9	13	0.86
Tetrachloroethylene	46	1.10	0-9.2	36	1.40	50	0.98	0-32	21	2.12
2-Chloro-1,3-butadiene	46	0.16	0-2.9	19	0.39	50	0.04	0-0.41	11	0.16
1,1-Dichloroethylene	46	0.00	-	0	-	51	0.00	-	0	-
Benzene	46	3.16	0.01-19	44	3.30	50	1.70	0.01-10.6	49	1.73
Toluene	46	8.40	0.01-33	45	8.59	50	2.62	0.01-13	48	2.71
Chlorobenzene	46	0.67	0-12	38	0.81	50	0.39	0-5.7	35	0.55
Nitrobenzene	46	0.00	0-0.01	0	-	50	0.00	-	0	-
Ortho xylene	37	1.32	0-4.5	34	1.44	43	1.06	0.01-10.1	39	1.17
Para/meta xylene	37	3.72	0.10-13	36	3.82	43	2.52	0.01-13	41	2.65
1,4-Dioxane	21	0.00	-	0	-	31	0.00	-	0	-
Methyl ethyl ketone	29	0.00	-	0	-	31	0.00	-	0	-
Methyl isobutyl ketone	21	0.01	0-0.25	1	0.25	31	0.00	0-0.01	0	-

Concentrations reported in parts per billion by volume

Zero quantities and quantities estimated as traces are not included in the quantifiable sample averages but are included in the all-sample averages.

TABLE 11 - 5   (CONTINUED)

SUMMARY OF SELECTED VOLATILE ORGANIC SUBSTANCE CONCENTRATIONS IN NEW JERSEY, 1979

| | PINE BARRENS (BATSTO) | | | | | CAMDEN | | | | |
| | All Samples | | | Quantifiable Samples | | All Samples | | | Quantifiable Samples | |
	# of Samples	Avg Conc	Range	# of Samples	Avg Conc	# of Samples	Avg Conc	Range	# of Samples	Avg Conc
Chloroform	42	0.00	0-0.01	0	-	23	0.00	0-0.01	0	-
Carbon Tetrachloride	42	0.01	0-0.10	0	-	23	0.01	0-0.10	0	-
1,2-Dichloroethane	42	0.00	0-0.01	0	-	23	0.00	0-0.01	0	-
1,1,2-Trichloroethane	42	0.00	0-0.01	0	-	21	0.00	-	0	-
1,2-Dibromoethane	38	0.00	0-0.01	0	-	23	0.41	0-5.5	8	1.55
1,1,2,2-Tetrachloroethane	42	0.04	0-1.6	1	1.60	23	0.00	0-0.01	0	-
Vinyl chloride	35	0.00	0-0.01	0	-	4	0.16	0-0.64	1	0.64
Trichloroethylene	42	0.08	0-1.3	4	0.79	23	0.43	0-3.5	10	0.97
Tetrachloroethylene	42	0.04	0-0.53	5	0.29	23	1.76	0-10	10	4.04
2-Chloro-1,3-butadiene	42	0.01	0-0.41	1	0.41	23	0.07	0-0.52	6	0.26
1,1-Dichloroethylene	42	0.00	-	0	-	23	0.00	-	0	-
Benzene	42	0.61	0-2.9	34	0.75	23	1.75	0.19-8.1	21	1.75
Toluene	42	0.59	0-3.5	32	0.78	23	6.97	0.23-38	21	6.97
Chlorobenzene	42	0.20	0-2.8	14	0.82	21	0.01	0.01-2.9	22	0.86
Nitrobenzene	42	0.00	-	0	-	23	0.00	-	0	-
Ortho xylene	38	0.14	0-1.2	20	0.27	23	2.14	0.05-15	23	2.14
Para/meta xylene	38	0.27	0-1.3	23	0.44	23	6.44	0.16-38	23	6.44
1,4-Dioxane	26	0.00	-	0	-	16	0.00	-	0	-
Methyl ethyl ketone	26	0.00	-	0	-	16	0.00	-	0	-
Methyl isobutyl ketone	26	0.00	0-0.11	3	0.11	16	0.00	0-0.01	0	-

Concentrations reported in parts per billion by volume

Zero quantities and quantities estimated as traces are not included in the quantifiable sample averages but are included in the all-sample averages.

APPENDIX G

HOUSTON REGIONAL MONITORING REPORT (EXCERPTS)

Houston Regional Monitoring Network
Summary Statistics Monitoring Results All Monitoring Stations
January 1, 1987 - December 31, 1995

Compound Name	Reporting Limits	Freq Detect	# Obs In Stats	Minimum (ppbv)	Maximum (ppbv)	Median (ppbv)	Arithmetic Mean	Std Dev	Lower 95% Confidence Limit	Upper 95% Confidence Limit
60 2-Butanone	0.18	47	2429	ND	31.59	ND	0.47	1.04	0.42	0.51
104 Methyl Isobutylketone	1.00	4	2798	ND	5.77	ND	0.15*	NR	NC	NC

Footnotes:

* : Value less than the reporting limit.

NC: No confidence

ND: Not detected

NR: Not reported

(a) Detection limits were empirically derived   (b) frequency of detection above and below OL

Houston Regional Monitoring Network

Summary Statistics Monitoring Results HRM Site 01 Monitoring Station

January 1, 1987 - December 31, 1995

Compound Name	Reporting Limits	Freq Detect	# Obs In Stats	Minimum (ppbv)	Maximum (ppbv)	Median (ppbv)	Arithmetic Mean	Std Dev	Lower 95% Confidence Limit	Upper 95% Confidence Limit
60 2-Butanone	0.18	51	367	ND	11.50	0.20	0.62	1.12	0.51	0.74
104 Methylisobutylketone	1.00	6	421	ND	1.48	ND	0.14*	NR	NC	NC

Footnotes:

* : Value less than the reporting limit.

NC: No confidence

ND: Not detected

NR: Not reported

(a) Detection limits were empirically derived   (b) Frequency of detection above and below DL

Houston Regional Monitoring Network

Summary Statistics Monitoring Results HRM Site 03 Monitoring Station

January 1, 1987 - December 31, 1995

Compound Name	Reporting Limits	Freq Detect	# Obs In Stats	Minimum (ppbv)	Maximum (ppbv)	Median (ppbv)	Arithmetic Mean	Std Dev	Lower 95% Confidence Limit	Upper 95% Confidence Limit
60 2-Butanone	0.18	46	361	ND	6.26	ND	0.48	0.73	0.41	0.56
104 Methylisobutylketone	1.00	5	416	ND	5.77	ND	0.17*	NR	NC	NC

Footnotes:

* : Value less than the reporting limit.

NC: No confidence

ND: Not detected

NR: Not reported

(a) Detection limits were empirically derived   (b) Frequency of detection above and below DL

Houston Regional Monitoring Network

Summary Statistics Monitoring Results HRM Site 04 Monitoring Station

January 1, 1987 - December 31, 1995

Compound Name	Reporting Limits	Freq Detect	# Obs In Stats	Minimum (ppbv)	Maximum (ppbv)	Median (ppbv)	Arithmetic Mean	Std Dev	Lower 95% Confidence Limit	Upper 95% Confidence Limit
60 2-Butanone	0.18	47	373	ND	12.92	ND	0.44	1.00	0.33	0.54
104 Methylisobutylketone	1.00	4	423	ND	0.55*	ND	0.13*	NR	NC	NC

Footnotes:

* : Value less than the reporting limit.

NC: No confidence

ND: Not detected

NR: Not reported

(a) Detection limits were empirically derived   (b) Frequency of detection above and below DL

Houston Regional Monitoring Network

Summary Statistics Monitoring Results HRM Site 07 Monitoring Station

January 1, 1987 - December 31, 1995

Compound Name	Reporting Limits	Freq Detect	# Obs In Stats	Minimum (ppbv)	Maximum (ppbv)	Median (ppbv)	Arithmetic Mean	Std Dev	Lower 95% Confidence Limit	Upper 95% Confidence Limit
60 2-Butanone	0.18	52	365	ND	10.38	0.23	0.53	0.86	0.44	0.62
104 Methylisobutylketone	1.00	4	418	ND	0.60*	ND	0.14^	NR	NC	NC

Footnotes:

* : Value less than the reporting limit.

NC: No confidence

ND: Not detected

NR: Not reported

(a) Detection limits were empirically derived   (b) Frequency of detection above and below DL

Houston Regional Monitoring Network

Summary Statistics Monitoring Results HRM Site 08 Monitoring Station

January 1, 1987 - December 31, 1995

Compound Name	Reporting Limits	Freq Detect	# Obs In Stats	Minimum (ppbv)	Maximum (ppbv)	Median (ppbv)	Arithmetic Mean	Std Dev	Lower 95% Confidence Limit	Upper 95% Confidence Limit
60 2-Butanone	0.18	48	374	ND	31.59	ND	0.46	1.70	0.29	0.64
104 Methylisobutylketone	1.00	2	424	ND	0.50ᵃ	ND	0.14*	NR	NC	NC

Footnotes:

* : Value less than the reporting limit.

NC: No confidence

ND: Not detected

NR: Not reported

(a) Detection limits were empirically derived   (b) Frequency of detection above and below DL

Houston Regional Monitoring Network
Summary Statistics Monitoring Results HRM Site 10 Monitoring Station
January 1, 1987 - December 31, 1995

Compound Name	Reporting Limits	Freq Detect	# Obs In Stats	Minimum (ppbv)	Maximum (ppbv)	Median (ppbv)	Arithmetic Mean	Std Dev	Lower 95% Confidence Limit	Upper 95% Confidence Limit
60 2-Butanone	0.18	44	226	ND	3.65	ND	0.31	0.46	0.25	0.37
104 Methylisobutylketone	1.00	4	279	ND	0.88*	ND	0.18*	NR	NC	NC

Footnotes:

* : Value less than the reporting limit.

NC: No confidence

ND: Not detected

NR: Not reported

(a) Detection limits were empirically derived   (b) Frequency of detection above and below DL

Houston Regional Monitoring Network
Summary Statistics Monitoring Results HRM Site 11 Monitoring station
January 1, 1987 - December 31, 1995

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Compound Name	Reporting Limits	Freq Detect	# Obs In Stats	Minimum (ppbv)	Maximum (ppbv)	Median (ppbv)	Arithmetic Mean	Std Dev	Lower 95% Confidence Limit	Upper 95% Confidence Limit
60 2-Butanone	0.18	12	363	ND	7.34	ND	0.36	0.68	0.29	0.43
104 Methylisobutylketone	1.00	2	417	ND	0.38*	ND	0.14*	NR	NC	NC

Footnotes:
* : Value less than the reporting limit.

NC: No confidence
ND: Not detected
NR: Not reported

(a) Detection limits were empirically derived   (b) Frequency of detection above and below CL

APPENDIX H

NORTH BATON ROUGE, LOUISIANA VOLATILE ORGANIC SCREENING STUDY

RADIAN
CORPORATION

DCN 88-203-085-02
RCN 203-085-05-00

RESULTS OF A VOLATILE
ORGANIC SCREENING STUDY CONDUCTED
IN THE VICINITY OF THE
NORTH BATON ROUGE INDUSTRIAL COMPLEX

DRAFT FINAL REPORT

Submitted to:

Mr. Gordon B. Jolley
Environmental Coordinator
Exxon Chemical Americas
Baton Rouge Chemical Plant
P.O. Box 241
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Prepared by:

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15 April 1988

RADIAN
CORPORATION

2.0   EXECUTIVE SUMMARY

This report describes the results of an ambient screening study
which was conducted for Exxon Chemical Americas by Radian Corporation. The
study was conducted in the immediate vicinity of the Baton Rouge industrial
complex and was aimed at measuring ambient concentrations of selected
volatile organic compounds which are representative of emissions from both
industrial stationary and area sources. The measurement program was
designed to gather simultaneous screening measurements for a list of 175
volatile organics (VOs) at four sites selected by Exxon Chemical Americas.

The sites were representative of the following types of locations:

1.   Rural non-industrial;

2.   An urban residential area situated near major transportation
      arteries;

3.   Urban industrial; and

4.   Rural industrial.

The location of each of the four sampling sites are shown in
Figure 2-1. Site 1 was a rural non-industrial site located 26 miles east of
the Baton Rouge industrial complex near the town of Livingston, Louisiana.
Site 2 was located in an urban area near the intersection of Highway 61 and
Siegen Lane. This site, which was located 10 miles southeast of the Baton
Rouge industrial complex, was dominated by mobile source emissions due to
its proximity to a major traffic intersection in Baton Rouge. Site 3 was
situated in an urban industrial area adjacent to the North Baton Rouge
refining and petrochemical complex. This site was situated approximately 1
mile east of the Exxon Chemical Americas plant on Evangeline Road. Site 4
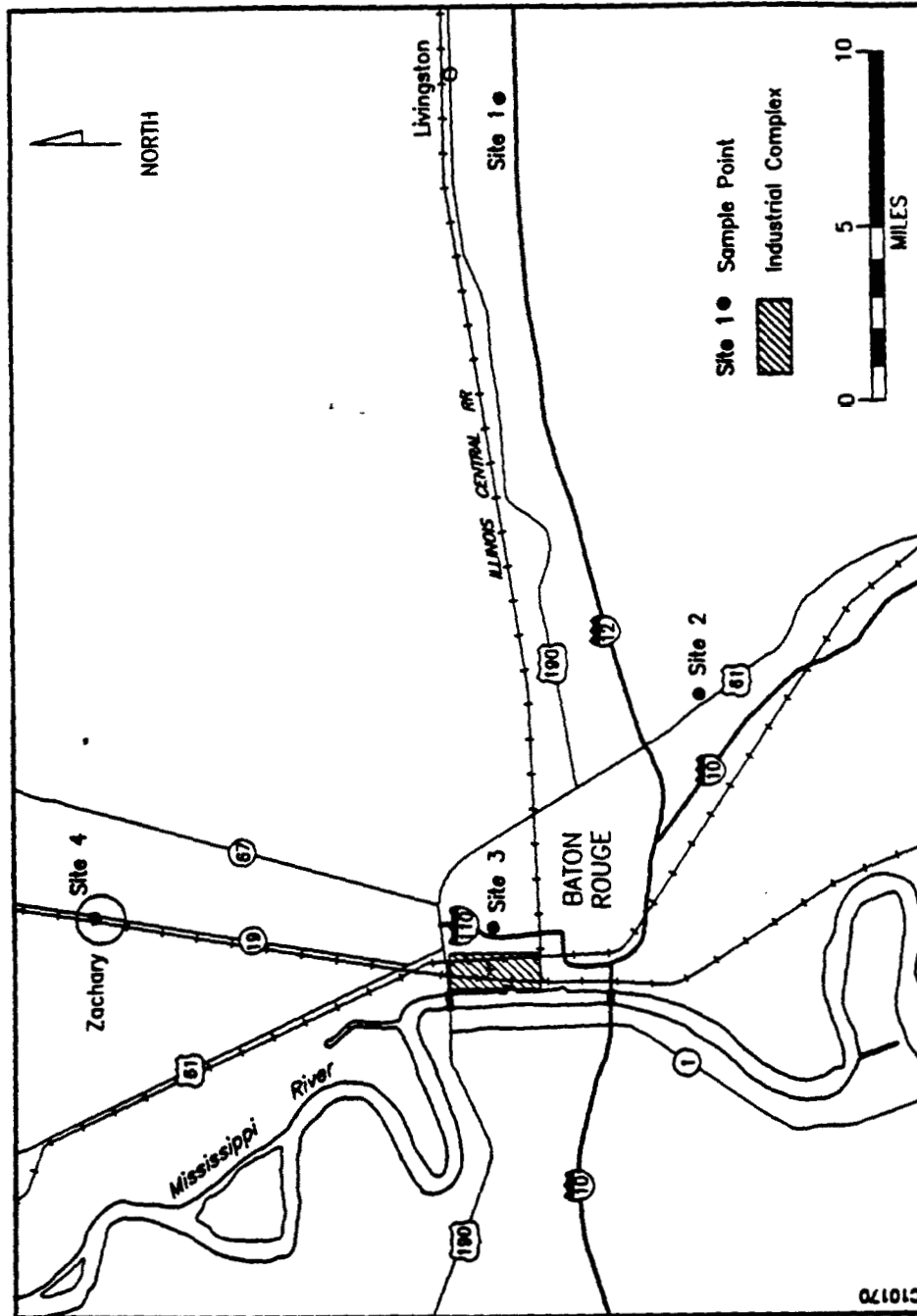was situated in a rural industrial setting in the town of Zachary,

Figure 2-1. Sampling Site Locations for Exxon Ambient Air Monitoring Program

Louisiana. This site was located 5 miles north of the Exxon Chemical Co. plastics plant.

Simultaneous 24-hour integrated whole air samples were collected at each of the four site locations on three consecutive sampling days beginning 6 March 1988 and extending through 9 March 1988. The samples were collected in evacuated stainless steel canisters, and analyzed using a multidetector gas chromatography system. The first sampling period was performed on a weekend (a Sunday) to gather samples during periods of low vehicular traffic. The remainder of the samples were collected during periods of normal weekday vehicular traffic. This sampling strategy was devised in an attempt to discriminate between impacts from stationary and mobile sources.

The meteorology during the measurement program was characterized by light winds which were predominately from a southeasterly direction. The first sampling period which began at 6:00 AM on the morning of 6 March 1988 was typified by light persistent westerly winds which gradually shifted through north and stabilized as a southeasterly breeze in the early morning of hours of 7 March. The winds were generally light and persistent from the southeast on 7-8 March; gradually shifting to the northwest during the late evening hours of 8 March. These conditions prevailed until sampling was terminated on the morning of 9 March 1988.

Based on the meteorology which existed during the measurement program, the urban and rural industrial sites (3 and 4) were positioned downwind of industrial sources for brief periods during the first and third sampling days. Site 2 (urban-residential) which was situated near a major traffic intersection, was exposed to emissions from mobile sources on each of the three sampling days. It should also be noted that light to moderate precipitation began at about noon of the second sampling day, and continued through the end of the third sampling day. The presence of precipitation may have influenced the concentration of volatile organics (VOs) which were present in the ambient environment at each site location.

Table 2-1 represents the list of compounds which were detected at least once at each site during the screening study. The table shows the concentration range, mean concentration, and frequency of observation for each compound detected. These data can be used to make inferences about the ambient levels of VO which were observed during the screening study (6-9 March 1988). Figures 2-2 through 2-7 provide a graphic comparison of the concentration levels which were observed at each site location for ethylene and acetylene, ethane, propane, benzene, toluene, and total non-methane hydrocarbons (TNMHC). The following general observations can be made with regard to the VO screening data:

- The concentration of TNMHC observed at each site during the study was generally low. The TNMHC values ranged from 78.8 to 239.4 ppb-v.

- The urban sampling sites were characterized by TNMHC values which were only slightly higher than that which was observed at the rural sampling sites. This is not surprising given the meteorological conditions which prevailed during the screening study.

- Ethane, ethylene and acetylene, propane, toluene, and n-heptane were present in at least 90% of all samples collected.

- As expected, there were a number of compounds which were generally present in higher concentrations at the urban-residential, and urban industrial sites as compared to the more isolated rural sites. These included benzene, ethylene and acetylene, toluene and ethane. These trends would be expected given the proximity to and number of stationary and mobile sources in the urban areas.

TABLE 2-1. EXXON BATON ROUGE SUMMARY TABLE

No.	Compound Name	Site 1 Range	Site 1 Mean	Site 1 Freq	Site 2 Range	Site 2 Mean	Site 2 Freq	Site 3 Range	Site 3 Mean	Site 3 Freq	Site 4 Range	Site 4 Mean	Site 4 Freq
1	Ethylene + Acetylene	1.0-3.2	2.6	100.0	6.7-11.8	9.3	100.0	5.8-16.1	10.5	100.0	3.1-13.7	9.1	100.0
2	Ethane	8.7-19.1	13.0	100.0	9.4-32.7	19.9	100.0	17.4-26.7	21.2	100.0	9.1-29.3	21.1	100.0
3	Propylene	0.6-1.4	1.1	100.0	1.4-3.6	2.8	100.0	0.9-3.3	2.4	100.0	1.9-3.6	3.0	100.0
4	Propane	3.6-17.3	9.3	100.0	5.1-21.0	11.4	100.0	8.0-13.2	9.9	100.0	3.5-14.8	8.1	100.0
7	Dichlorodifluoromethane	ND-11.9	4.3	33.3	ND-4.0	2.4	66.7	ND-ND		0.0	ND-ND		0.0
8	Isobutane	ND-6.7	3.4	66.7	2.5-9.9	5.1	100.0	3.8-6.1	4.7	100.0	1.2-3.3	2.0	100.0
11	Isobutene + 1-Butene	ND-1.9	1.2	66.7	ND-3.6	1.3	33.3	1.8-2.4	2.1	100.0	1.9-5.1	5.0	100.0
12	1,3-Butadiene	ND-0.4	0.2	33.3	ND-0.5	0.3	33.3	ND-ND		0.0	ND-0.5	0.3	33.3
16	n-Butane	ND-9.4	3.2	33.3	ND-23.2	8.1	66.7	ND-14.0	8.0	66.7	2.2-8.2	4.7	100.0
17	t-2-Butene	ND-ND		0.0	ND-1.1	0.4	33.3	ND-ND		0.0	ND-ND		0.0
19	1-Butyne	ND-1.8	0.4	33.3	ND-ND		0.0	ND-ND		0.0	ND-ND		0.0
23	3-Methyl-1-Butene	ND-1.6	0.6	33.3	ND-ND		0.0	ND-ND		0.0	ND-ND		0.0
25	Ethanol	ND-14.2	5.5	66.7	ND-2.6	1.0	33.3	ND-ND		0.0	ND-ND		0.0
26	Isopentane	ND-29.3	9.8	33.3	5.5-9.6	7.7	100.0	ND-3.2	1.1	33.3	ND-3.1	1.9	66.7
29	Trichlorofluoromethane	ND-12.5	4.5	33.3	ND-79.6	26.9	33.3	ND-31.9	11.0	33.3	ND-ND		0.0
34	2-Methyl-1-Butene	ND-ND		0.0	ND-0.5	0.2	33.3	ND-1.1	0.4	33.3	ND-ND		0.0
36	n-Pentane	ND-2.4	1.2	66.7	ND-4.8	1.7	33.3	ND-6.5	3.3	66.7	ND-2.2	1.4	66.7
37	Isoprene	ND-ND		0.0	ND-0.3	0.2	33.3	ND-ND		0.0	ND-ND		0.0
41	t-2-Pentene	ND-ND		0.0	ND-0.7	0.3	33.3	ND-2.4	1.1	66.7	ND-1.1	0.6	66.7
43	c-2-Pentene	ND-ND		0.0	ND-0.5	0.2	33.3	ND-1.2	0.5	66.7	ND-ND		0.0
45	2-Methyl-2-Butene	ND-ND		0.0	ND-0.6	0.3	33.3	ND-0.8	0.3	66.7	ND-ND		0.0
46	Hexane	ND-ND		0.0	ND-0.2	0.1	33.3	ND-2.1	0.8	33.3	ND-0.5	0.2	33.3
52	Cyclopentane	ND-1.3	0.5	33.3	0.3-4.0	1.7	100.0	ND-ND		0.0	ND-ND		0.0
54	2,3-Dimethylbutane	ND-0.2	0.1	33.3	ND-1.1	0.4	33.3	ND-0.3	0.2	33.3	ND-1.4	0.3	33.3
57	Isohexane	ND-0.8	0.3	33.3	0.2-2.8	1.1	100.0	ND-0.8	0.3	33.3	ND-6.0	2.7	66.7
60	2-Butanone	ND-0.7	0.3	33.3	ND-6.1	2.1	33.3	ND-2.9	1.0	33.3	ND-9.5	3.2	33.3
61	3-Methylpentane	0.3-3.2	1.3	100.0	0.3-1.8	0.9	100.0	ND-0.7	0.3	33.3	ND-2.2	1.4	66.7
62	1-Hexene	ND-ND		0.0	ND-ND		0.0	ND-1.3	0.5	33.3	ND-ND		0.0
66	n-Hexane	ND-0.8	0.3	33.3	0.3-4.1	1.9	100.0	ND-0.8	0.3	33.3	ND-1.3	0.6	66.7
68	c-3-Hexene	ND-ND		0.0	ND-0.2	0.1	33.3	ND-ND		0.0	ND-ND		0.0
69	t-2-Hexene	ND-1.0	0.4	33.3	ND-1.3	0.5	66.7	ND-ND		0.0	ND-ND		0.0
71	c-2-Hexene	ND-ND		0.0	ND-0.6	0.4	66.7	ND-ND		0.0	ND-ND		0.0

TABLE 2-1. (Continued)

No.	Compound Name	Site 1			Site 2			Site 3			Site 4		
		Range	Mean	Freq	Range	Mean	Freq	Range	Mean	Freq	Range	Mean	Freq
73	Methylcyclopentane	ND-0.4	0.2	33.3	ND-1.6	1.0	66.7	ND-0.9	0.3	33.3	ND-0.9	0.3	66.7
75	2,4-Dimethylpentane	ND-0.7	0.3	66.7	0.8-1.0	0.9	100.0	ND-1.3	0.3	33.3	ND-0.4	0.2	33.3
79	Benzene	ND-0.4	0.3	33.3	ND-2.6	1.8	66.7	0.8-2.9	1.8	100.0	ND-2.3	1.3	66.7
81	1-Butanol	ND-ND		0.0	ND-3.5	1.9	33.3	ND-ND		0.0	ND-ND		0.0
85	Cyclohexane	ND-0.2	0.1	33.3	0.5-1.1	0.8	100.0	ND-0.5	0.4	66.7	ND-0.4	0.2	33.3
86	Isopentane + 2,3-Dimethylpentane	ND-1.4	0.6	66.7	0.4-2.8	1.4	100.0	ND-1.7	0.8	66.7	ND-0.8	0.4	66.7
87	3-Methylhexane	ND-0.6	0.3	66.7	ND-2.8	1.3	66.7	0.3-1.3	1.0	100.0	ND-ND		0.0
90	3-Pentanone	ND-1.3	0.5	33.3	ND-3.1	1.1	33.3	ND-ND		0.0	ND-ND		0.0
94	2,3,4-Trimethylpentane	ND-ND		0.0	0.7-3.5	1.7	100.0	ND-1.7	0.6	33.3	ND-1.2	0.4	33.3
95	n-Heptane	0.3-2.1	0.9	100.0	0.3-1.1	0.8	100.0	0.7-1.7	1.3	100.0	0.3-0.4	0.4	100.0
101	Methylcyclohexane	ND-0.4	0.2	33.3	ND-1.0	0.4	66.7	0.3-1.0	0.7	100.0	ND-0.7	0.4	66.7
106	2,3-Dimethylhexane	ND-ND		0.0	ND-0.7	0.3	100.0	ND-ND		0.0	ND-ND		0.0
107	2,2,3-Trimethylpentane	ND-0.5	0.2	33.3	0.3-1.4	0.7	100.0	0.3-0.9	0.6	100.0	0.3-1.4	0.8	100.0
110	2,3,4-Trimethylpentane	ND-1.0	0.7	66.7	0.3-3.3	1.6	100.0	ND-2.8	1.1	66.7	ND-0.3	0.2	33.3
111	Toluene	1.4-3.2	2.5	100.0	2.0-5.9	4.3	100.0	1.5-5.8	3.4	100.0	1.4-3.3	2.2	100.0
116	1-Methylcyclohexane	ND-ND		0.0	ND-ND		0.0	ND-ND		0.0	ND-1.6	0.6	33.3
118	Hexanal	ND-ND		0.0	ND-2.3	1.2	33.3	ND-ND		0.0	ND-ND		0.0
121	2,2,5-Trimethylhexane	ND-ND		0.0	ND-0.7	0.4	66.7	ND-0.3	0.1	33.3	ND-ND		0.0
126	n-Octane	ND-0.2	0.1	33.3	ND-0.6	0.3	66.7	ND-0.4	0.2	66.7	ND-0.9	0.3	33.3
129	Ethylbenzene	ND-ND		0.0	ND-0.9	0.3	66.7	ND-1.4	0.8	66.7	ND-ND		0.0
131	p-Xylene + m-Xylene	ND-0.3	0.3	66.7	0.4-2.6	1.4	100.0	ND-2.1	0.9	66.7	ND-1.4	0.9	66.7
134	Styrene	ND-0.6	0.3	33.3	ND-0.8	0.5	66.7	ND-ND		0.0	ND-0.7	0.3	33.3
137	o-Xylene	ND-3.3	1.2	66.7	ND-1.3	0.6	66.7	ND-0.9	0.3	33.3	ND-0.5	0.3	66.7
139	Nonane	ND-1.3	0.5	33.3	ND-1.7	0.7	66.7	ND-0.5	0.3	66.7	ND-ND		0.0
142	Pinene	ND-ND		0.0	ND-ND		0.0	ND-0.8	0.3	33.3	ND-ND		0.0
148	m-Ethyltoluene	ND-0.3	0.2	66.7	ND-0.8	0.4	66.7	ND-0.7	0.3	44.7	ND-0.2	0.1	33.3
150	p-Ethyltoluene	ND-0.2	0.1	66.7	ND-0.5	0.2	66.7	ND-0.4	0.2	66.7	ND-0.4	0.2	33.3
151	1,3,5-Trimethylbenzene	ND-ND		0.0	0.2-0.6	0.4	100.0	ND-0.7	0.3	66.7	ND-0.8	0.3	33.3
152	o-Ethyltoluene	ND-0.5	0.2	33.3	ND-0.4	0.2	66.7	ND-0.4	0.2	66.7	ND-ND		0.0
153	Pinene	ND-ND		0.0	ND-ND		0.0	ND-0.4	0.1	33.3	ND-ND		0.0
155	1,2,4-Trimethylbenzene	ND-1.4	0.6	66.7	ND-1.0	0.5	66.7	ND-0.8	0.3	33.3	ND-0.5	0.2	33.3
156	t-Butylbenzene	ND-1.1	0.5	66.7	ND-0.5	0.2	33.3	0.4-0.6	0.5	100.0	ND-1.0	0.4	66.7
159	n-Decane	ND-0.3	0.2	66.7	ND-1.2	0.4	33.3	ND-0.3	0.2	66.7	ND-ND		0.0

TABLE 2-1. (Continued)

No.	Compound Name	Site 1 Range	Site 1 Mean	Site 1 Freq	Site 2 Range	Site 2 Mean	Site 2 Freq	Site 3 Range	Site 3 Mean	Site 3 Freq	Site 4 Range	Site 4 Mean	Site 4 Freq
166	1,2,3-Trimethylbenzene	ND-0.3	0.2	33.3	0.6-2.3	1.3	100.0	ND-0.3	0.2	66.7	ND-ND	-	0.0
167	m-Diethylbenzene	ND-ND	-	0.0	ND-ND	-	0.0	ND-0.3	0.1	33.3	ND-1.0	0.4	33.3
168	n-Butylbenzene	ND-0.3	0.1	33.3	ND-0.7	0.3	66.7	ND-ND	-	0.0	ND-0.6	0.3	66.7
169	p-Diethylbenzene	ND-0.2	0.1	33.3	ND-0.4	0.2	33.3	ND-0.5	0.2	33.3	ND-0.5	0.3	66.7
170	1-Undecene	ND-0.2	0.1	33.3	ND-0.3	0.2	66.7	ND-0.2	0.1	33.3	ND-0.2	0.1	33.3
171	n-Undecane	ND-0.9	0.4	66.7	0.1-0.5	0.3	100.0	0.2-0.4	0.3	100.0	ND-1.4	0.6	66.7
172	Naphthalene	ND-0.5	0.2	33.3	ND-1.0	0.4	33.3	ND-1.1	0.4	33.3	ND-ND	-	0.0
	Total Identified VOC's	42.7-106.4	75.5		80.6-184.2	139.8		76.4-121.6	99.4		37.9-106.6	77.0	
	Total Unidentified VOC's	32.3-147.8	89.0		48.4-62.6	52.7		33.7-47.5	42.2		40.9-73.8	59.8	
	Total Non-Methane Hydrocarbons	129.6-217.9	164.5		121.0-239.4	192.5		110.2-167.1	141.6		78.8-180.3	136.8	

*: Compounds are regulated under SARA TITLE III and CERCLA

Site 1: Livingston, LA. (rural site)

Site 2: Airline and Siegen Roads in Baton Rouge (urban)

Site 3: Evangeline Fire Station (urban-industrial)

Site 4: Zachary, LA. (rural neighborhoods)
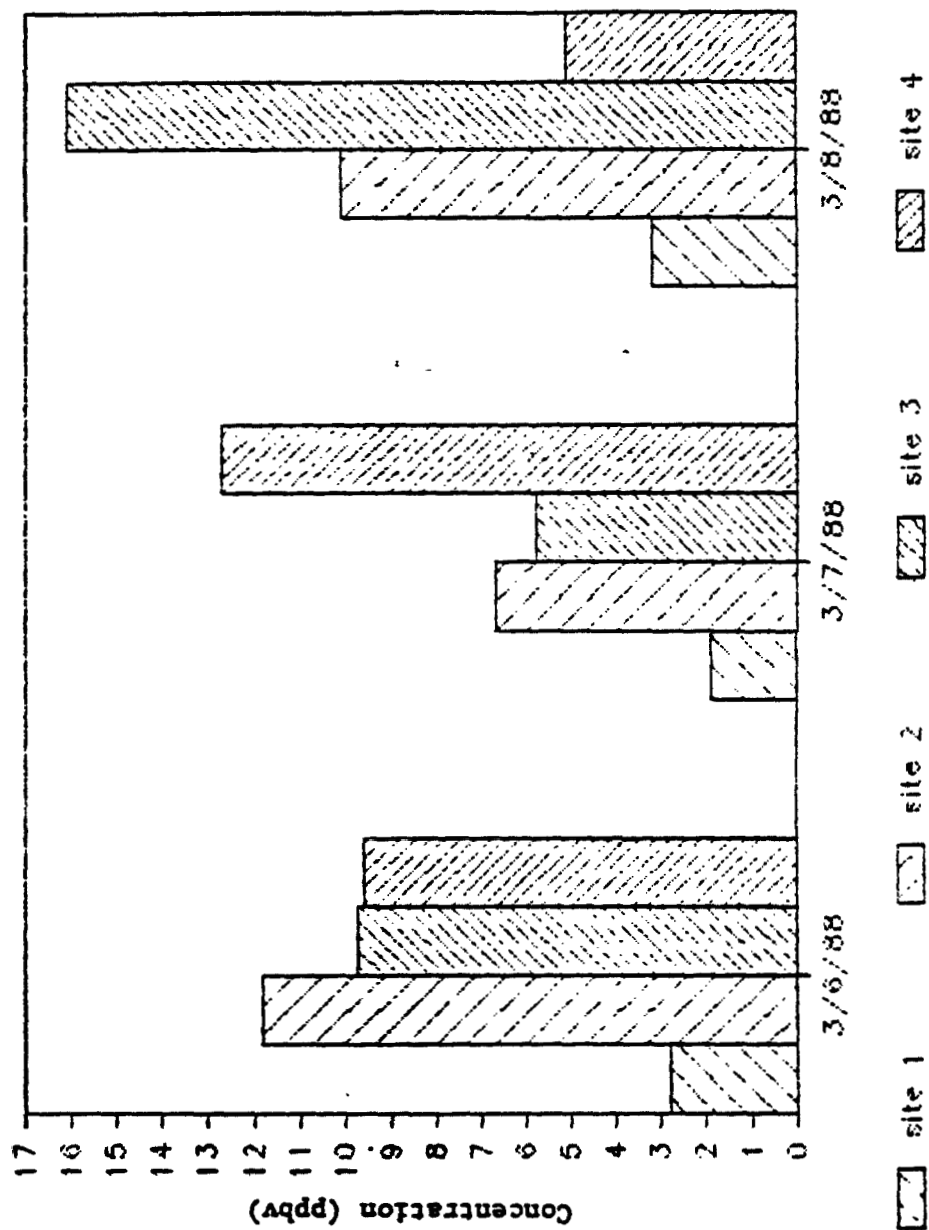
Figure 2-2. Exxon Baton Rouge Bar Graph Data for Ethylene and Acetylene
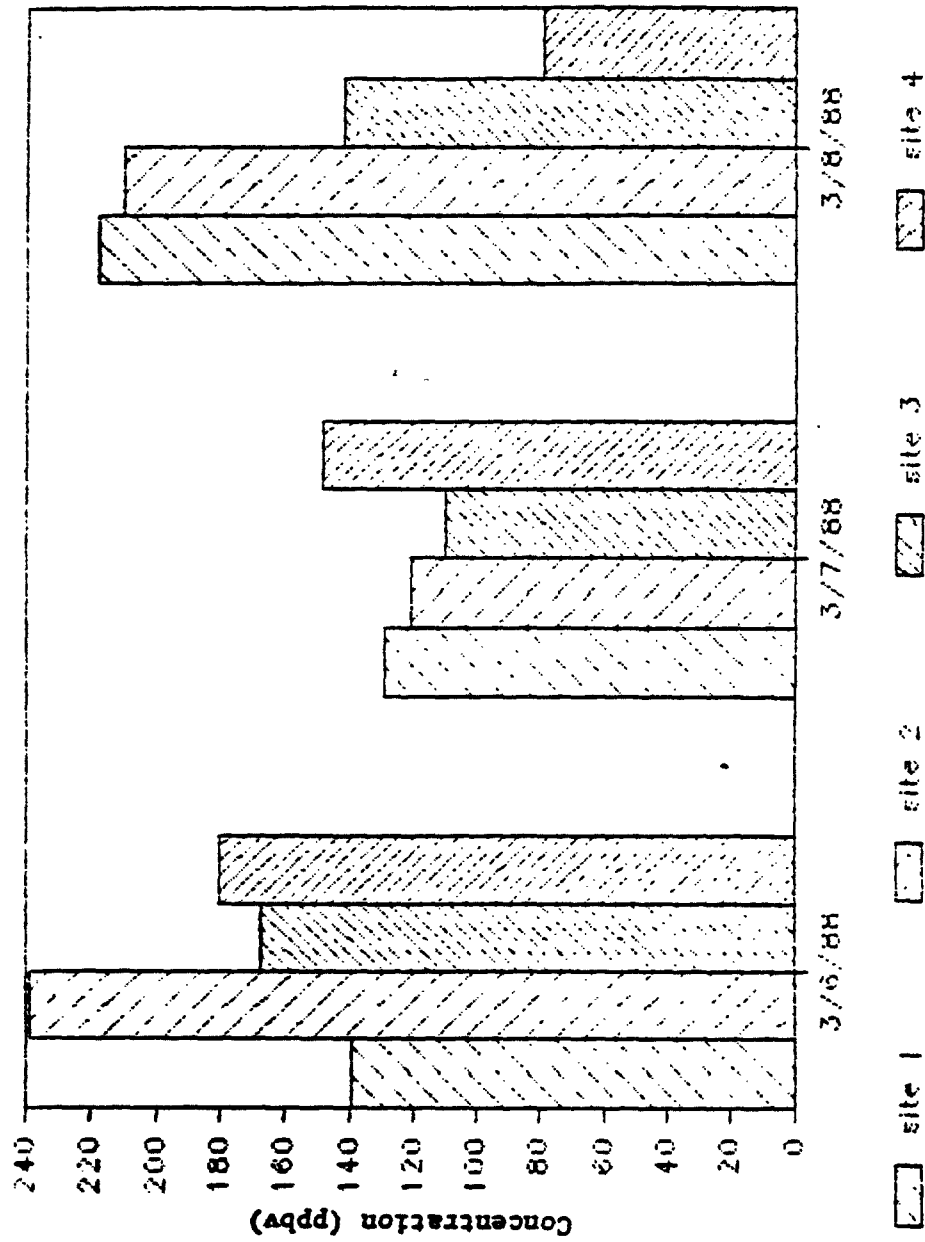
Figure 2-7. Exxon Baton Rouge Total Non-Methane
Hydrocarbon Bar Graph

RADIAN
CORPORATION

- There were fifteen (15) compounds which were detected at the urban and urban industrial site locations which were not present at detectable concentrations at the rural locations. Most notable were c-2-pentene, ethylbenzene, and 2-methyl-2-butene.

- The majority of compounds which were identified were present at concentrations of 5 ppb-v or less. Ethane, propane, n-butane, isopentane, and trichlorofluoromethane were observed in some samples at concentrations greater than 20 ppb-v.

- Precipitation during the sampling program may have been responsible for suppressing the VO concentration in the ambient environment. In general, the TNMHC levels were lower on days in which precipitation was measured.

- Given the limited number of samples collected and the meteorology which existed during the screening program, it is uncertain if the data collected are representative of the highest concentrations of VOs which could be present in the ambient air. The data, however are representative of short duration screening measurements observed at each site under similar sampling conditions.

- During the data validation process, it was discovered that acetaldehyde, acetone, methylene chloride, and 3-methyl heptane were present in the field blanks. Measurement values for these compounds were at levels which would normally not be expected in the ambient air. For this reason, these data were excluded from the summary presentation.

During the sampling program, two samplers failed to operate for the entire 24-hour sampling period. This included a sample collected at Site 1 on 6 March, and at Site 4 on the evening of 7 March. In the case of

the sample collected at Site 1, it was discovered that both the designated field and duplicate canisters had been tampered with and the valve on each canister was turned off approximately midway through the sampling period. The duplicate sample was repeated during the next sampling period. In the second case, sample flow ceased as a result of excessive moisture accumulation in the vacuum flow delivery system during a time when moderate rainfall was occurring. In both instances, the samplers operated for periods of approximately 12 hours. It is difficult to assess if the aborted samples are representative of samples collected over a full 24-hour sampling period. Because the samples were collected in isolated areas, it could be argued that the concentration of VOs in the ambient air would be relatively constant over a 24-hour period. The data do provide useful information concerning the composition of volatile organic compounds which were observed at these sites. However, care should be exercised in interpreting these data.

The ambient VO measurements made during this study provide a "quick screen look" at the distribution of volatile organics in the Baton Rouge industrial corridor over a limited time frame. These data are useful in contrasting the composition and relative concentrations of volatile organics which are present in urban/industrial settings to those found in rural and rural industrial settings. As previously stated, the measurement data presented in this report may not be representative of the highest concentration values which would be expected to occur under different meteorological scenarios. Therefore, care should be taken in applying broad interpretations to this limited database. These data, however, do provide an indication of the general air quality which was observed at each measurement site under the conditions which prevailed during the measurement program. Additional data, however, are needed to accurately assess community exposure to a variety of volatile indicator compounds which are representative of emissions from petroleum refining, petrochemical production, and mobile sources in the North Baton Rouge industrial complex.

APPENDIX I

REPORT ON THE ENSR MODELING STUDY

Chemical Manufacturers Association (CMA)

Ketones Panel

Dispersion Modeling to Estimate Ambient Concentrations Associated with Sources of MEK

EXECUTIVE SUMMARY

Title III of the 1990 Clean Air Act Amendments (CAAA) identified 189 Hazardous Air Pollutants (HAP) to be regulated under Section 112 of the Clean Air Act (CAA). The CAAA contain provisions for the HAP list to be modified through a petition process. The Ketones Panel of the Chemical Manufacturers Association (CMA) is petitioning U.S. EPA to delete methyl ethyl ketone (MEK) from the HAP list. As part of this petition, CMA is seeking to develop information pertaining to ambient airborne concentrations in the vicinity of sources emitting MEK to the air. ENSR, under contract to CMA, has estimated maximum off-site MEK concentrations through the application of U.S. EPA recommended air dispersion modeling procedures.

The Toxic Release Inventory (TRI) database was used to identify the top emitters of MEK (annual emissions of 200 tons per year or more), as well as classes of other facilities with annual MEK emissions of more than 10 tons per year. Companies representing these top emitters were contacted by CMA and requested to provide site-specific information for atmospheric dispersion modeling. Dispersion modeling of facility MEK emissions from the top emitting facilities was conducted by application of the EPA's recommended approach for CAA HAP petitions (Tiered Modeling Approach for Assessing Risks Due to Sources of Hazardous Air Pollutants). This approach identifies three tiers of analysis that are progressively more rigorous with each successive tier, resulting in more realistic modeled concentrations. Dispersion modeling analysis indicates that, with one exception not representative of human exposure, maximum annual off-site concentrations of MEK around the highest emitting facilities are below 1 mg/m^3 and maximum 24-hour concentrations are below 10 mg/m^3.

Other MEK facilities (emitting 10 to 200 tons per year) were sorted by SIC code and a generalized modeling approach was applied. This generalized approach is based on dispersion modeling previously conducted by EPA in support of Section 112(g) of the Clean Air Act. Generalized dispersion modeling indicates that maximum annual off-site concentrations are below 1 mg/m^3 in the vicinity of these lesser emitting facilities and are likely to be well below 1 mg/m^3 in most cases.

An analysis was also conducted to determine whether multiple sources of MEK emissions in the same area might result in significant air impacts. It was concluded that there is no significant overlap of emissions and that combined impacts from multiple facilities emitting MEK will not cause maximum annual concentrations greater than 1.0 mg/m^3 or maximum 24-hour concentrations greater than 10 mg/m^3.

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1.0 INTRODUCTION

1.1 Purpose

Title III of the 1990 Clean Air Act Amendments (CAAA) identified 189 Hazardous Air Pollutants (HAP) to be regulated under Section 112 of the Clean Air Act (CAA). The CAAA contain provisions for the HAP list to be modified through a petition process. The Ketones Panel of the Chemical Manufacturers Association (CMA) is petitioning U.S.EPA to delete methyl ethyl ketone (MEK) from the HAP list. As part of this petition, CMA is seeking to develop information pertaining to ambient airborne concentrations in the vicinity of sources emitting MEK to the air. ENSR is under contract to CMA to estimate maximum off-site MEK concentrations through the application of U.S.EPA recommended air dispersion modeling procedures.

1.2 Identification and Selection of Sources

ENSR's analysis was divided into three parts. First, because airborne concentrations are likely to be highest in the vicinity of the top emitters of MEK, ENSR conducted refined modeling for a large number of major MEK emitters using site-specific information provided by the facilities or, in a few cases, obtained from publicly available sources. The Toxic Release Inventory (TRI) database was reviewed to identify all sources for which annual emissions equaled or exceeded 200 tons per year, since these facilities have the greatest potential for adverse off-site exposure. Twenty-six manufacturing facilities identified from the TRI review were contacted by CMA and requested to provide detailed source information so that site-specific atmospheric dispersion modeling of MEK emissions could be conducted.

Second, ENSR developed a generalized approach for analyzing maximum airborne concentrations in the vicinity of lesser emitting facilities. All facilities that reported more than 10 tons of MEK emissions on the 1994 TRI were divided into source categories based on their two-digit SIC codes. ENSR developed parameters for each SIC code and then used a generalized EPA model to predict likely maximum airborne concentrations based on the annual emission rates for the highest and second highest emitting facilities in each SIC code.

Third, an analysis was conducted to determine whether multiple sources of MEK emissions in the same area might result in significant air impacts. All facilities emitting greater than 10 tons of MEK were identified and sorted by postal ZIP code. Groups of sources were evaluated to determine the potential for overlapping emissions.

1.3   Dispersion Modeling Approach

Dispersion modeling of entire facility MEK emissions from the top emitting facilities was conducted by application of the EPA's Tiered Modeling Approach for Assessing Risks Due to Sources of Hazardous Air Pollutants (EPA, 1992). This approach identifies three tiers of analysis that are progressively more rigorous, with each successive tier resulting in more realistic modeled concentrations. The first tier tends toward the most overprediction, requires the least detailed input data and uses simple look-up tables. The second tier uses standardized EPA screening modeling techniques that more realistically include plume rise and building downwash but are still designed to be relatively conservative, i.e., to overestimate air quality impacts. The third tier uses refined dispersion modeling following EPA's Guideline on Air Quality Models (Revised) (U.S. EPA, 1995) and provides the most realistic impacts. Facilities that were identified as "top emitters" were first modeled using both Tier 1 and Tier 2 methods. Selected facilities among those with higher Tier 2 modeled impacts were also modeled using the refined Tier 3 techniques.

For facilities below the 400,000 lb annual MEK emissions threshold, ENSR used a generalized modeling approach based on the model developed by EPA as part of the Agency's rulemaking under Section 112(g) of the Clean Air Act (EPA, 1993). The EPA model results in a dispersion coefficient, based on a small number of input parameters, that is applied to an emission rate. ENSR adjusted the EPA model to incorporate worst-case meteorological conditions, and then used it to predict maximum airborne concentrations for model facilities. These facilities were selected to represent each SIC code, not otherwise represented by one or more of the top emitters, that had at least one facility reporting more than 10 tons of MEK emissions in 1994. The generalized approach was also applied to the remaining top emitters for which sufficient site information could not be obtained.

1.4   Summary of Study Findings

1. Refined dispersion modeling estimates of emissions from all facilities reporting 400,000 pounds or more of MEK emissions in 1994 indicates that, with one exception, maximum annual off-site concentrations of MEK around these facilities are below 1 mg/m^3 and maximum 24-hour concentrations are below 10 mg/m^3. For one facility, the maximum annual off-site concentration was 1.18 mg/m^3 and the maximum 24-hour concentration was 12.82 mg/m^3. However, for this facility, the point of the highest predicted concentrations was not at a location where 24-hour or annual exposure could occur.

2. Generalized dispersion modeling of lesser MEK emitters indicates that maximum annual off-site concentrations are likely to be below 1 mg/m^3 in all cases, and well below 1 mg/m^3 in most cases.

3. There is little or no potential for significant air quality impacts from multiple sources of MEK emissions in the same area. That is, combined emissions from multiple sources will not cause maximum annual MEK concentrations greater than 1.0 mg/m^3 or maximum 24-hour concentrations greater than 10 mg/m^3.

1.5 Report Organization

This report is organized as follows. A description of the approach used to identify and collect pertinent modeling input data from sources is provided in Section 2. Section 3 describes the dispersion modeling methods applied to the top emitters. Modeling results for top emitters are presented in Section 4. Section 5 discusses the method used to model emissions from smaller sources and presents the results of this analysis. Section 6 then addresses the issue of collective emissions from multiple sources. Section 7 summarizes the study findings. Appendix A provides the forms that were used to solicit source information for modeling and Appendix B provides further information on the generic method used to model emissions from lesser MEK sources.

2.0 SOURCES SUBJECT TO SITE SPECIFIC MODELING

2.1 Identification of Top Emitters

The Ketones Panel has undertaken a program to gather data on the maximum airborne concentrations of MEK to which the public may be exposed. As part of this program, the Panel funded a study by ENSR to model the maximum off-site concentrations of MEK at the largest sources of MEK emissions in the country. To identify the facilities to be included in this study, the Ketones Panel used the methodology that EPA developed to set de minimis values for hazardous air pollutants under Section 112(g) of the Clean Air Act (EPA, 1993). The de minimis value for a chemical is the amount that an EPA model facility could emit without posing more than a "trivial" risk to human health or the environment. EPA has proposed to "cap" de minimis levels at 10 tons per year, but EPA's methodology may also be used to calculate true "uncapped" de minimis values for different compounds. Using EPA's methodology, the uncapped value for MEK is 2,000 tons (or 4,000,000 pounds) per year, calculated using an inhalation reference concentration (RfC) of 1.0 mg/m^3, which is the existing value in the IRIS database.[1] In order to establish a meaningful cutoff point for its modeling exercise, the Panel decided that it would seek to model all facilities with reported emissions that were 10 percent or more of the uncapped de minimis value. Thus, it sought to model the maximum off-site concentrations for all facilities reporting MEK emissions of 200 tons (400,000 pounds) or more per year. Based on 1993 TRI data, the Panel identified 30 such facilities.

2.2 Solicitation of Data

The Panel also worked with ENSR to develop a detailed questionnaire to gather the information that would be necessary to model the maximum off-site concentrations at each facility. This questionnaire, along with a cover letter explaining the Panel's modeling program and the protection of confidential information, was sent to the 30 facilities. Representatives from the Panel also contacted each of the facilities to encourage their participation. By the time the Panel received the necessary data and ENSR began its modeling exercise, the TRI data for 1994 had become available. From 1993 to 1994, the number of facilities reporting MEK TRI emissions greater than 200 tons had dropped from 30 to 26. Table 2-1 lists each of the facilities that

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[1] Since the RfC was established in the IRIS database, EPA has issued new guidelines for setting RfCs. Based on the new guidelines, the Ketones Panel has calculated that the correct RfC for MEK is 3.3 mg/m^3.

TABLE 2-1

Listing of Top MEK Emitters

Company	Facility Location	TRI 1994 Emissions (lbs)	2 Digit SIC Code
Gencorp	Columbus, MS	2,026,760	22 (Nonwoven Fabrics)
O'Sullivan	Winchester, VA	1,366,079	30 (Plastics)
IPC	Corinth, MS	1,256,755	30 (Plastics)
Mobil Oil	Beaumont, TX	1,216,000	29 (Refining)
3M Specialties	Hutchinson, MN	1,010,000	36 (Electronic)
Columbus Fabrics	Columbus, OH	867,838	22 (Coated Fabrics)
Texas Recreation Corp	Wichita Falls, TX	790,100	30 (Plastics)
Uniroyal	Stoughton, WI	714,199	22 (Nonwoven Fabrics)
Sun Refining	Tulsa, OK	701,000*	29 (Refining)
Alcoa	Riverdale, IA	694,000	33 (Aluminum)
ResiliteSports	Northumberland, PA	648,757**	39 (Misc. Mfg.)
3M Specialties	Kearneysville, WV	626,360	35 (Ind. Machinery)
R.J. Reynolds Tobacco	Winston-Salem, NC	609,594	21 (Cigarettes)
Reynolds Metals	Sheffield, AL	578,000	34 (Metal Coating)
Amoco Corp.	Whiting, IN	558,000	29 (Refining)
Plastene Supply Co.	Portageville, MO	550,373	34 (Metal Coating)
Sony Products	Dothan, AL	540,291	36 (Electronic)
Shell Oil	Deer Park, TX	536,370	29 (Refining)
Norandal USA Inc.	Newport, AR	518,175	33 (Aluminum)
3M Specialties	White City, OR	517,000	38 (Measuring Inst.)
Textileather Corp.	Toledo, OH	510,000	22 (Nonwoven Fabrics)
Allied Tube and Conduit	Harvey, IL	506,000	33 (Aluminum)
Textron Automotive	Americus, GA	489,189	37 (Mot. Veh. Parts)
Reynolds Metals	Richmond, VA	405,000	33 (Aluminum)
Boeing	Everett, WA	400,000	37 (Airline)
Sun Oil Co.	Yabucoa, PR	400,000	29 (Refining)
Athol Corp.	Butner, NC	397,000	22 (Nonwoven Fabrics)

** Sun Refining and Marketing Co. has informed the Ketones Panel that it recently conducted emissions tests which indicate that its 1994 MEK emissions to the air were overstated by a significant amount, and were actually well below 400,000 pounds. The 1995 Form R for this facility more accurately reports air emissions of 241,000 pounds. Based on this information the Panel has not included dispersion modeling results for this facility.

** Resilite provided 1995 MEK emissions (367,839 lbs) to be used in the assessment.

reported MEK emissions of greater than 200 tons on the 1994 TRI, along with the SIC code for each facility.

As noted in Table 2-1, three of the listed facilities have revised MEK emissions that are below the 200 ton criterion that is used to define the top-emitters. The rule of thumb applied is that such a facility would be included in the top-emitter assessment if the revised annual MEK emissions exceeded 90% of the 200 ton criterion. Thus, Resilite Sports was included in the analysis along with Athol Corporation, for which the MEK TRI emissions estimate dropped to just below 200 tons in 1994.

The SIC codes indicate that the top-emitting facilities represent a wide variety of industries. Facility-specific data needed for modeling was received from 14 facilities, including the 4 highest emitters. In addition, one facility provided results of dispersion modeling for MEK emissions that had already been conducted independent of this study. Thus, facility specific information or pre-existing dispersion modeling results were obtained from 15 of the 26 highest-emitting MEK sources in the country, including 6 of the top 10.

In order to conduct dispersion modeling for the other 11 facilities identified as top emitters, the Panel and ENSR attempted to obtain relevant facility data from public sources. For each facility, we conducted a search on EPA's Aerometric Information Retrieval System (AIRS) database. In addition, we contacted state and local regulatory officials to determine whether a Title V permit application or similar document had been submitted by any of the remaining facilities. Title V permit applications were obtained for 4 of the 11 remaining facilities. Based on the information available from the AIRS database and permit applications, ENSR was able to conduct refined dispersion modeling for 5 of the 11 facilities that did not provide information directly to ENSR. In situations where detailed information on specific data elements (such as stack height, building height, etc.) were not available from these sources, reasonable, conservative estimates of these elements were made. For the other 6 facilities, no facility-specific data was available. For each of these facilities, ENSR modeled maximum off-site concentrations using the generalized model described in Section 5.

Table 2-2 shows the basis for modeling each of the 26 top-emitting facilities. Table 2-3 shows specific data elements that were obtained from publicly available sources for facilities that were modeled based on limited data, as well as the estimates that were made in the absence of such data. Listed in Table 2-4 are facilities for which a generalized modeling approach was applied because no relevant data were obtained.

TABLE 2-2

Basis for Dispersion Modeling

Site Specific Information Provided by the Following Companies:
Gencorp - Columbus, MS
O'Sullivan - Winchester, VA
IPC - Corinth, MS
Mobil Oil - Beaumont, TX
Columbus Fabrics - Columbus, OH
Uniroyal - Stoughton, WI
Resilite Sports - Northumberland, PA
Reynolds Metals - Sheffield, AL
Amoco Corp. - Whiting, IN
Sony Products - Dothan, AL
Shell Oil - Deer Park, TX
Textileather Corp. - Toledo, OH
Sun Oil Co. - Yabucoa, PR
Athol Corp. - Butner, NC
Model Results Provided by the Following Companies:
R.J. Reynolds Tobacco - Winston-Salem, NC
Site Specific Modeling Based on Public Data for the Following Companies:
3M Specialties - Hutchinson, MN
3M Specialties - Kearneysville, WV
3M Specialties - White City, OR
Allied Tube and Conduit - Harvey, IL
Boeing - Everett, WA
Generalized Modeling - EPA 112(g) Methodology performed for the Following Companies:
Texas Recreation Corp. - Wichita Falls, TX
Alcoa - Riverdale, IA
Plastene Supply Co. - Portageville, MO
Norandal USA Inc. - Newport, AZ
Textron Automotive - Americus, GA
Reynolds Metals - Richmond, VA

TABLE 2-3

Alternative Modeling Parameters for Non-Participants of Survey

Company Facility Location	TRI 1994 Emissions (lbs/yr)	Data Sources	Modeling Parameters Applied*				
			Stack Ht (m)	Temp. (K)	Velocity (m/s)	Bldg. Ht. (m)	Fenceline Dist. (m)**
3M Specialties Division Hutchinson, MN	1,010,000	Title V permit appl. AIRS	12	293	5.0	10.0	100
3M Specialties Division Kearneysville, WV	626,360	AIRS	9.1	293	0.0	7.6	100
3M Specialties Division White City, OR	517,000	Title V permit appl.	10.0	293	0.0	9.1	90
Allied Tube and Conduit Harvey, IL	506,000	Title V permit appl.	9.1	293	0.0	7.6	150
Boeing Everett, WA	400,000	Title V permit appl.	21.3	293	0.0	20.0	500

* All MEK assumed emitted from single point source.
** Fenceline distances determined from plot plans provided in Title V permit applications except for 3M, Kearneysville, WV, for which the fenceline distance was estimated from site acreage provided by AIRS.

TABLE 2-4

Non-Participants for which Generalized Modeling was Conducted

Company Facility Location	TRI 1994 Emissions (lbs/yr)
Texas Recreation Corp. Wichita Falls, TX	790,100
Alcoa Riverdale, IA	694,000
Plastene Supply Co. Portageville, MO	550,373
Norandal USA Inc. Newport, AR	518,175
Textron Automotive Americus, GA	489,100
Reynolds Metals Richmond, VA	405,000

Facilities participating in the CMA program provided site-specific data for modeling based on conditions of confidentiality. To this end, anonymity of modeling results was achieved by assigning a code to each participating facility. In addition, tables providing model input information which are normally provided in dispersion reports conducted, for example, in support of permit applications, have not been included.

2.3 Source Characterization

The questionnaire sent to participating companies requested the following information:

General information: facility plot plan showing property boundary, fenceline, source locations, building and storage tank height, location indicated on a topographic map
Point source information: emission rate, release height, temperature, flow rate, effective diameter, flow obstruction

Area source information: emission rate, height, site of the area

This information was used to develop input for dispersion modeling of MEK emissions. The actual annual emissions provided by the facilities were used to estimate annual average concentrations. In 4 cases, emissions data provided by the companies were slightly (less than 3%) lower than the emissions reported in the TRI. In one case, modeling was based on 1993 TRI emissions which exceeded 1994 TRI reported emissions by approximately 10%. For Reslite Sports modeled emissions were 43% less than the 1994 TRI data.

To model maximum 24-hour off-site concentrations, ENSR used maximum daily MEK emissions rates in the few instances where such information was provided by the facility. Otherwise, the maximum 24-hour concentrations were computed applying a daily emission rate based on the annual emissions divided by 260 days, (i.e., assuming that the facilities operate on a five-day-per-week schedule).

3.0 DISPERSION MODELING METHODS FOR TOP EMITTERS OF MEK

ENSR performed air quality modeling analyses for each of the top-emitting MEK facilities using EPA's "Tiered Modeling Approach for Assessing Risks Due to Sources of Hazardous Air Pollutants" (1992). This approach uses three progressively more rigorous modeling techniques. Tier 1, which requires only limited source information and a look-up table, provides the most conservative predictions of maximum concentrations. Tier 2, which requires additional source information and uses an EPA screening-level computer program, generates predictions that are somewhat more realistic than Tier 1 predictions. Tier 3, which requires extensive data from the source and uses EPA's refined dispersion modeling techniques, provides the most realistic predicted concentrations. Because each successive tier provides a less conservative (and more realistic) prediction, Tier 3 modeling was generally performed for a facility only if Tier 2 modeling predicted maximum annual concentrations were above 2 mg/m^3.

In all of these modeling methods, MEK is assumed to disperse in the atmosphere as a passive tracer, not subject to removal through deposition or chemical reaction during transport. This is a reasonable assumption given the typically short transport time (less than 10 minutes) from the source to the point of maximum impact.

3.1 Tier 1 Modeling Approach

The Tier 1 approach is based on a parameterization of EPA screening models. It is comprised of a set of look-up tables. Information required for Tier 1 modeling include:

- emission rate
- point source height
- size of area source
- distance to nearest property line

The look-up tables provide emission-normalized 1-hour and annual concentrations for each source. These concentrations are multiplied by the corresponding source-specific emission rate to calculate the maximum off-site concentration. The maximum concentrations from individual sources are then added to estimate an overall maximum annual and 1-hour concentrations. To estimate maximum 24-hour MEK concentrations, the Tier 1 1-hour concentrations were multiplied by a time averaging factor of 0.4, as recommended in U.S. EPA's screening modeling guidance (U.S. EPA, 1992a). The Tier 1 estimate is highly conservative because it does not account for

plume rise or above ground area sources and assumes that maximum contributions from all sources are cumulative at a single receptor point.

Tier 1 Example

The Tier 1 method is illustrated by the following example provided in the EPA guidance document. Consider the situation in which a toxic pollutant A is released at a rate of 14.6 ton/yr from a vent-pipe that is 40 m tall, and which is attached to a building that is 4 m tall, 10 m long, and 5 m wide. The nearest boundary of the facility is located 65 m from the vent. Table 3-1 is EPA's look-up table for determining Tier 1 maximum annual concentrations. A value of 35 m is selected for the emission height, because all larger entries in the table exceed the actual release height of 40 m. Concentrations are estimated for a distance of 50 m, because once again, all greater entries in the table exceed the actual distance of 65 m. The appropriate normalized maximum annual concentration is 1.13 (μg/m^3)/(ton/yr). Multiplying by the emission rate of 14.6 ton/yr results in a maximum annual concentration estimate for screening purposes equal to 16.5 μg/m^3.

3.2   Tier 2 Modeling Approach

Tier 2 uses a computerized U.S. EPA screening model, SCREEN3, to estimate maximum off-site concentrations. SCREEN3 predicts maximum 1-hour concentrations which are then multiplied by a scaling factor of 0.4 to estimate maximum 24-hour concentrations and 0.08 to estimate maximum annual concentrations (U.S. EPA, 1992a). In addition to the information required for Tier 1 modeling, Tier 2 modeling requires:

- inner stack diameter
- stack gas exit velocity
- stack gas temperature
- worst-case building dimensions for aerodynamic downwash simulation
- rural/urban dispersion environment classification

U.S.G.S. topographic maps were examined to determine land use within a 3 km radius of each of the top-emitting facilities. If over 50% of the area has urban land use, then SCREEN3 was applied with urban dispersion coefficients. Otherwise, rural dispersion was specified. If the classification of an area was ambiguous, the model was run in both modes and the greater of the two results was used in the assessment.

TABLE 3-1 Normalized Maximum Annual Concentrations, $(\mu g/m^3)/(T/yr)$

Source type[a]	Emission height, m	Side length[b], m	Normalized maximum concentration at or beyond:[c]					
			10 m	30 m	50 m	100 m	200 m	500 m
A	0	10	9.56E+2	3.02E+2	1.64E+2	6.48E+1	2.32E+1	5.53E+0
A	0	20	5.15E+2	1.83E+2	1.07E+2	4.78E+1	1.91E+1	5.04E+0
A	0	30	3.51E+2	1.31E+2	7.92E+1	3.74E+1	1.61E+1	4.58E+0
P	0	--	5.41E+3	7.92E+2	3.25E+2	9.67E+1	2.91E+1	6.08E+0
P	2	--	1.87E+2	1.42E+2	1.35E+2	7.28E+1	2.64E+1	5.96E+0
P	5	--	9.62E+1	7.46E+1	5.18E+1	2.72E+1	1.48E+1	5.18E+0
P	10	--	2.77E+1	2.44E+1	2.11E+1	1.36E+1	7.17E+0	2.88E+0
P	20	--	6.91E+0	4.52E+0	4.52E+0	3.80E+0	2.44E+0	1.06E+0
P	35	--	2.26E+0	2.26E+0	1.13E+0	1.11E+0	8.98E-1	4.41E-1
P	50	--	1.11E+0	1.10E+0	1.11E+0	4.69E-1	4.23E-1	2.53E-1

[a] Source type P = Point source, type A = Area source.
[b] Side length of square area source.
[c] Distance downwind of an area source indicates distance from downwind edge of the area source.

SCREEN3 simulates building downwash based on the dimensions of the structure, which result in the highest Good Engineering Practice stack height, determined by the formula: GEP = building height + 1.5 x L (where L is the lesser of building height or width).

All buildings within a distance of 5L are considered.

SCREEN3 modeling was performed separately for each point and area source with receptors placed at a distance closest to the nearest fenceline and at 100 m intervals to 2 km assuming flat terrain. As was the case with the Tier 1 calculations, the maximum modeled impacts for multiple sources were assumed to completely overlap, such that the Tier 2 modeled estimate is highly conservative.

Tier 2 Example

To illustrate the Tier 2 long-term analysis, consider the Tier 1 example. To consider downwash possibilities, the maximum horizontal dimension $\{(10m)^2 + (5m)^2]^{1/2} = 11.2m\}$ is first compared to the 4 m building height. The dimension L is then the building height of 4m, such that the maximum stack height for which downwash is possible would be 4m + 1.5 X 4m = 10m. Since the actual stack height is 40 m, downwash need not be considered in the SCREEN3 simulation. The emission rate specified in the example of 14.6 ton/yr is converted to grams per second (g/sec) to be used in the SCREEN3 simulation, resulting in an annual emission rate of 14.6/34.73 = 0.42 g/sec. In addition to the actual stack height (40m) and minimum fenceline distance (65m), input parameters for the SCREEN3 simulation are:

Inside stack diameter	0.5m
Stack gas exit velocity	5.6 m/s
Stack gas exit temperature	303 K
Plant location	urban

The results from the SCREEN3 simulation indicate that the maximum 1-hour concentration (based on an annual emission rate) at or beyond 65m is 32.5 $\mu g/m^3$, occurring 165m downwind. After incorporating the recommended conversion factor of 0.08, the maximum annual concentration is estimated as 2.6 $\mu g/m^3$ - a value that is a factor of 6 lower than the Tier 1 estimate of 16.5 $\mu g/m^3$.

3.3   Tier 3 modeling approach

Tier 1 and 2 screening was used to predict maximum annual and maximum 24-hour concentrations for all top emitting facilities for which adequate data were available. Refined Tier 3 modeling was applied only to those few facilities with the highest modeled Tier 2 concentrations.

Modeling was performed in accordance with the EPA tiered approach and Guidelines on Air Quality Models (EPA 1992, 1995). The modeling applied the U.S. EPA's Industrial Source Complex Short Term Model (ISCST3), which is the guideline model for simulating point sources subject to aerodynamic building downwash and area sources. ISCST3 incorporates information on the facility layout with respect to property boundary, source location and building dimensions and can compute concentrations for 24-hour and annual averaging periods. As shown in Figure 3-1, model receptors were placed along the property boundary and in a 100 m x 100 m square grid out to 2000 m. Given that all of the sources modeled were either area sources or point sources subject to building wake effects, maximum modeled off-site concentrations always occurred adjacent to the property boundary. As such, variation in terrain surrounding the facility was not considered in the assessment. Refined Tier 3 modeling used representative, National Weather Service (NWS) surface and mixing height data, obtained from U.S. EPA's SCRAMS Bulletin Board. Meteorological site selection was based on proximity and geographical setting. Five years of meteorological data were modeled and the maximum annual and 24-hour concentrations among each of the five years of data were used in the impact assessment. That is, the annual concentration represents the highest average concentration occurring for any single year over the five years modeled, and the 24-hour concentration is the highest concentration that was modeled for any day over the entire 5 year period.
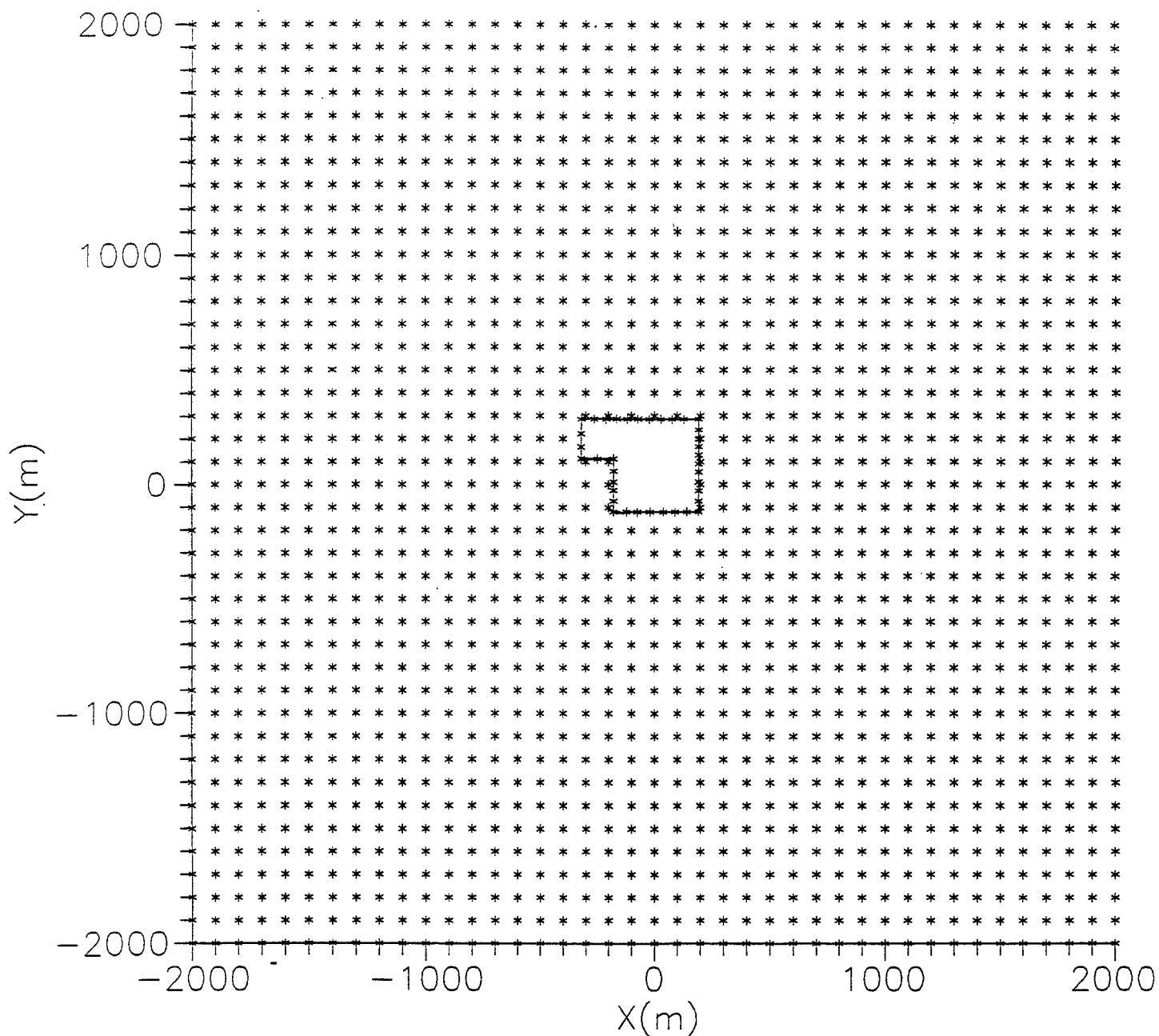
FIGURE 3-1

Sample Receptor Grid Used in Tier 3 Modeling

4.0 EVALUATION OF MAXIMUM OFF-SITE CONCENTRATIONS
AT HIGHEST EMITTING FACILITIES

Results of the tiered modeling for top MEK emission sources are provided in Tables 4-1 and 4-3 for maximum annual and 24-hour concentrations, respectively. Tables 4-2 and 4-4 present the same data sorted according to how the information for modeling was obtained. Facilities are ranked according to Tier 2 modeling results, in descending order. Of the top facilities, 19 had Tier 1 and 2 screening performed and 7 had additional Tier 3 refined modeling performed. One facility had already conducted screening or refined modeling independently of this study. For the 6 top emitting facilities for which site information was not obtained, the values listed on the tables are based on the generalized modeling approach discussed in Section 5.

It is important to recognize that the health benchmarks for MEK are based on continuous exposure. The RfC (3.3 mg/m^3) is specifically designed to be protective for continuous exposure for a lifetime of 70 years, and the 24-hour benchmark (33.0 mg/m^3) is designed to be protective for continuous exposure over a 24-hour period. The maximum off-site concentrations computed in this assessment, however, are not intended to represent actual population exposure. In many instances it is unlikely that locations where maximum off-site concentrations are modeled are places where continuous exposure can actually occur. In every case, modeled maximum off-site concentrations are located near the facility boundaries. The top MEK emitters are large facilities which are likely to be surrounded by industrial and commercial properties. As such, receptors close to the facility boundaries are areas where the exposure time is typically no more, and probably significantly less, than 8 hours per day, 5 days per week rather than continuous. It is also important to recognize that the off-site concentrations computed in this assessment are maximum annual and 24-hour concentrations. Even at the worst-case fenceline locations, actual off-site concentrations averaged over one-year and 24-hour periods are likely to be lower.

Table 4-1 shows that the highest modeled annual Tier 2 concentration, which occurs for facility E17, is about 12 mg/m^3 and the corresponding Tier 3 concentration is 1.2 mg/m^3. The model receptor where the maximum concentration occurs is located across the roadway from facility E17, near the vehicular entrance to an industrial area. As such, it does not represent a receptor where 24-hour exposure is possible. The modeled annual concentration at the second highest off-site receptor at this facility is 0.81 mg/m^3. Annual Tier 3 concentrations at all other facilities are also below 1 mg/m^3.

Tier 3 modeling was conducted for each facility at which the Tier 2 predicted concentration was greater than 2.0 mg/m^3. The highest Tier 2 concentration for which refined modeling was not conducted is 1.77 mg/m^3. As anticipated, Tier 3 concentrations are substantially lower than the

TABLE 4-1

MEK Dispersion Modeling Results for Top Emitters
Maximum Annual Average

Site	Max Annual MEK Concentration (mg/m³) (RfC = 3.3 mg/m³)+		
	Tier 1	Tier 2	Tier 3
E17	29.0	12.33	1.18
E9	33.0	11.2	0.91
E28	13.7	4.75	0.81
E7	14.5	3.97	0.50
E25	38.1	3.37	0.42
E4	17.1	2.99	0.55
E3	12.3	2.65	0.63
E20	19.4	1.77	-
E33*	5.5	1.56	-
E19*	8.5	1.42	-
E21	14.6	1.37	-
E14*	6.9	1.23	-
E29	26.5	1.13	-
E16*	6.9	0.69	-
E23	9.9	0.46	-
E8	9.7	0.42	-
E32	6.2	0.18	-
E1	9.2	0.12	-
E11*	0.2	0.1	-
E15	-	-	0.03**

*Model input parameters for non-participating facilities have been estimated from available data sources (see Table 2-2).

** Based on dispersion modeling results provided by individual companies.

+ Based on RfC for MEK in EPA's IRIS database updated to reflect 1994 EPA guidance on deriving RfCs. Updated RfC provided by CMA Ketones Panel.

TABLE 4-2

MEK Dispersion Modeling Results for Top Emitters
Maximum Annual Average

Site	Max Annual MEK Concentration (mg/m³) (RfC = 3.3 mg/m³)		
	Tier 1	Tier 2	Tier 3
Site Specific Modeling Completed			
E17	29.0	12.33	1.18
E9	33.0	11.2	0.91
E28	13.7	4.75	0.81
E7	14.5	3.97	0.50
E25	38.1	3.37	0.42
E4	17.1	2.99	0.55
E3	12.3	2.65	0.63
E20	19.4	1.77	-
E21	14.6	1.37	-
E29	26.5	1.13	-
E23	9.9	0.46	-
E8	9.7	0.42	-
E32	6.2	0.18	
E1	9.2	0.12	-
Site Specific Modeling Completed Based on Public Data			
E33	5.5	1.56	
E19	8.5	1.42	
E14	6.9	1.23	
E16	6.9	0.69	
E11	0.2	0.1	-
Modeling Results Provided			
E15	-	-	0.03
Generalized Modeling Results			
Site	1994 TRI Emissions (lb)	Table 4 Factor (DC*) (mg/m³ per MMlb)	Max Annual MEK Concentration (mg/m³)
E12	790,100	0.91 (M)	0.72
E2	694,000	0.39 (H)	0.27
E10	550,373	0.91 (M)	0.50
E18	518,175	0.91 (M)	0.47
E34	489,189	0.39 (H)	0.19
E35	405,000	0.39 (H)	0.16

* Dispersion Category

TABLE 4-3

MEK Dispersion Modeling Results for Top Emitters
Maximum 24-Hour Average

Site	Max 24-hr Concentration (mg/m³) (Benchmark = 33.0 mg/m³)+		
	Tier 1	Tier 2	Tier 3
E17	186.8	86.3	12.82
E9	196.2	64.0	7.42
E28	137.0	33.3	5.24
E7	81.9	27.8	4.67
E3	58.2	18.5	2.44
E25	232.3	16.85	2.77
E4	73.0	15.63	7.57
E20	108.5	12.39	-
E19*	47.6	9.91	-
E21	146.3	9.57	-
E14*	38.3	8.58	-
E33*	35.0	8.27	-
E29	144.2	7.91	-
E16*	38.5	4.86	-
E23	115.2	3.21	-
E8	54.4	2.93	-
E32	35.0	1.23	-
E11*	1.2	0.72	-
E1	36.7	0.59	-
E15	-	-	0.35**

*Model input parameters for non-participating facilities have been estimated from available data sources (see Table 2-2).

** Based on dispersion modeling results provided by individual companies.

+ Based on updated RfC modified to eliminate uncertainty factor for extrapolating from chronic to subchronic exposures. Value provided by CMA Ketones Panel.

TABLE 4-4

MEK Dispersion Modeling Results for Top Emitters
Maximum 24-Hour Average

Site	Max 24-hr Concentration (mg/m³) (Benchmark = 33.0 mg/m³)		
	Tier 1	Tier 2	Tier 3
Site Specific Modeling Completed			
E17	186.8	86.3	12.82
E9	196.2	64.0	7.42
E28	137.0	33.3	5.24
E7	81.9	27.8	4.67
E3	58.2	18.5	2.44
E25	232.3	16.85	2.77
E4	73.0	15.63	7.57
E20	108.5	12.39	-
E21	146.3	9.57	
E29	144.2	7.91	
E23	115.2	3.21	
E8	54.4	2.93	-
E32	35.0	1.23	
E1	36.7	0.59	
Site Specific Modeling Completed Based on Public Data			
E33	35.0	10.89	-
E19	47.6	9.91	-
E14	38.3	8.58	-
E16	38.5	4.86	-
11	1.2	0.72	-
Modeling Results Provided			
E15	-	-	0.35

corresponding Tier 2 results. For the seven facilities for which Tier 3 modeling was performed, the Tier 3 value was between 76% and 92% lower than the corresponding Tier 2 value, with an average of 85%. Thus, it appears reasonable to anticipate that Tier 3 values will be lower than corresponding Tier 2 values by at least 76%.

For illustrative purposes, this reduction factor has been applied to develop "adjusted Tier 2" values for all of the remaining sites for which Tier 2 modeling (but not Tier 3 modeling) has been conducted. The highest adjusted Tier 2 value is 0.42 mg/m^3 (1.77 x 0.24). The predicted maximum annual off-site concentrations for all the top emitting facilities are plotted on Figure 4-1, with adjusted Tier 2 values shown where Tier 3 values were not computed. As indicated on Figure 4-1, maximum off-site annual concentrations at all of the top emitting facilities are well below the RfC of 3.3 mg/m^3 and, in most cases, are well below 1 mg/m^3. The average of the maximum annual off-site concentrations at the top-emitting facilities (including adjusted Tier 2 values where Tier 3 values were not derived) is about 0.3 mg/m^3.

Modeled maximum 24-hour average concentrations are provided in Table 4-3. The highest off-site Tier 3 concentration of 13 mg/m^3 (for facility E17), occurs at the same isolated receptor as has been noted for the annual modeling and is not representative of public exposure. The second highest concentration among all other off-site receptors in the vicinity of that facility is 8.3 mg/m^3. All other Tier 3 modeling results are below 10 mg/m^3. Where Tier 3 modeling was performed, the Tier 3 24-hour concentrations were between 51% and 91% lower than the corresponding Tier 2 value, with an average of 80%. Thus, it appears reasonable to anticipate that Tier 3 24-hour values will be lower than the corresponding Tier 2 values by at least 51%.

For facilities for which Tier 3 modeling was not performed, adjusted Tier 2 24-hour concentrations were estimated by reducing the Tier 2 value by 51%. This results in a maximum adjusted Tier 2 24-hour concentration of about 6 mg/m^3. Figure 4-2 shows Tier 3 and adjusted Tier 2 maximum 24-hour off-site concentrations for all of the top-emitting MEK facilities. As indicated on Figure 4-2, maximum 24-hour concentrations at all of the top emitting facilities are well below the health benchmark of 33 mg/m^3 and, in most cases, are well below 10 mg/m^3.

In evaluating the maximum 24-hour concentrations, it is again important to recognize that they are intended to represent maximum off-site concentrations, not actual human exposure. As noted above, these concentrations were predicted to occur at or near the facility fenceline, where continuous 24-hour human exposures are unlikely. The predicted maximum 24-hour concentrations are also based on the worst-case dispersion meteorology occurring in the area of the facility during any day over a 5 year period, and should therefore be viewed as being conservative.

Figure 4-1

Refined MEK Modeling Estimates*
Maximum Annual Average Off-site Concentrations

RfC = 3.3 mg/m³

* Based on Tier 3 and adjusted Tier 2 values.

Concentration (mg/m³)

Facilities

E17 E9 E28 E7 E25 E3 E4 E20 E33 E19 E21 E14 E29 E16 E23 E8 E32 E1 E11 E15

Figure 4-2

Refined MEK Modeling Estimates*
Maximum 24-Hour Average Off-site Concentrations

Benchmark = 33.0 mg/m³

* Based on Tier 3 and adjusted Tier 2 values.

Concentration (mg/m³)

40
30
20
10
0

Facilities

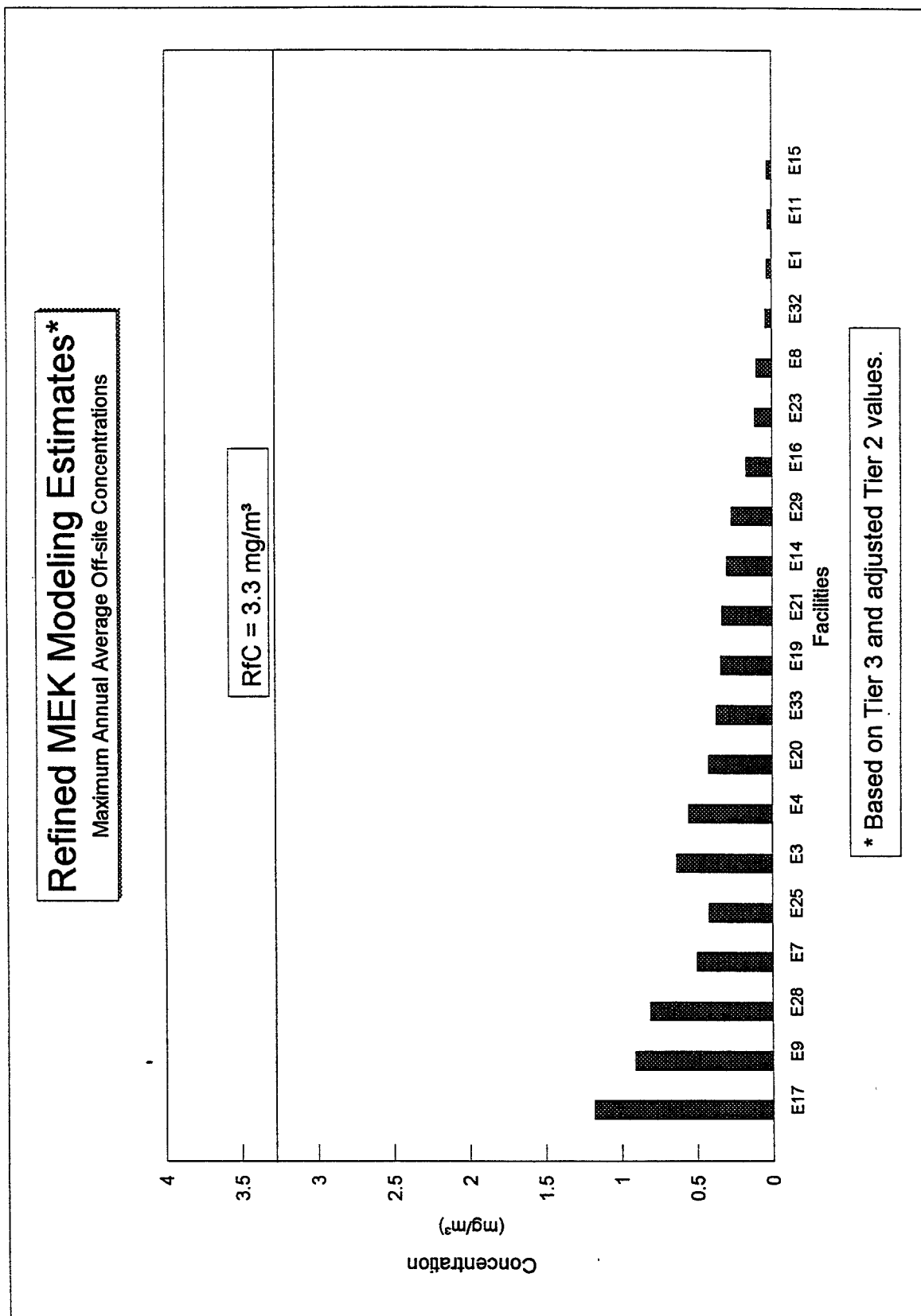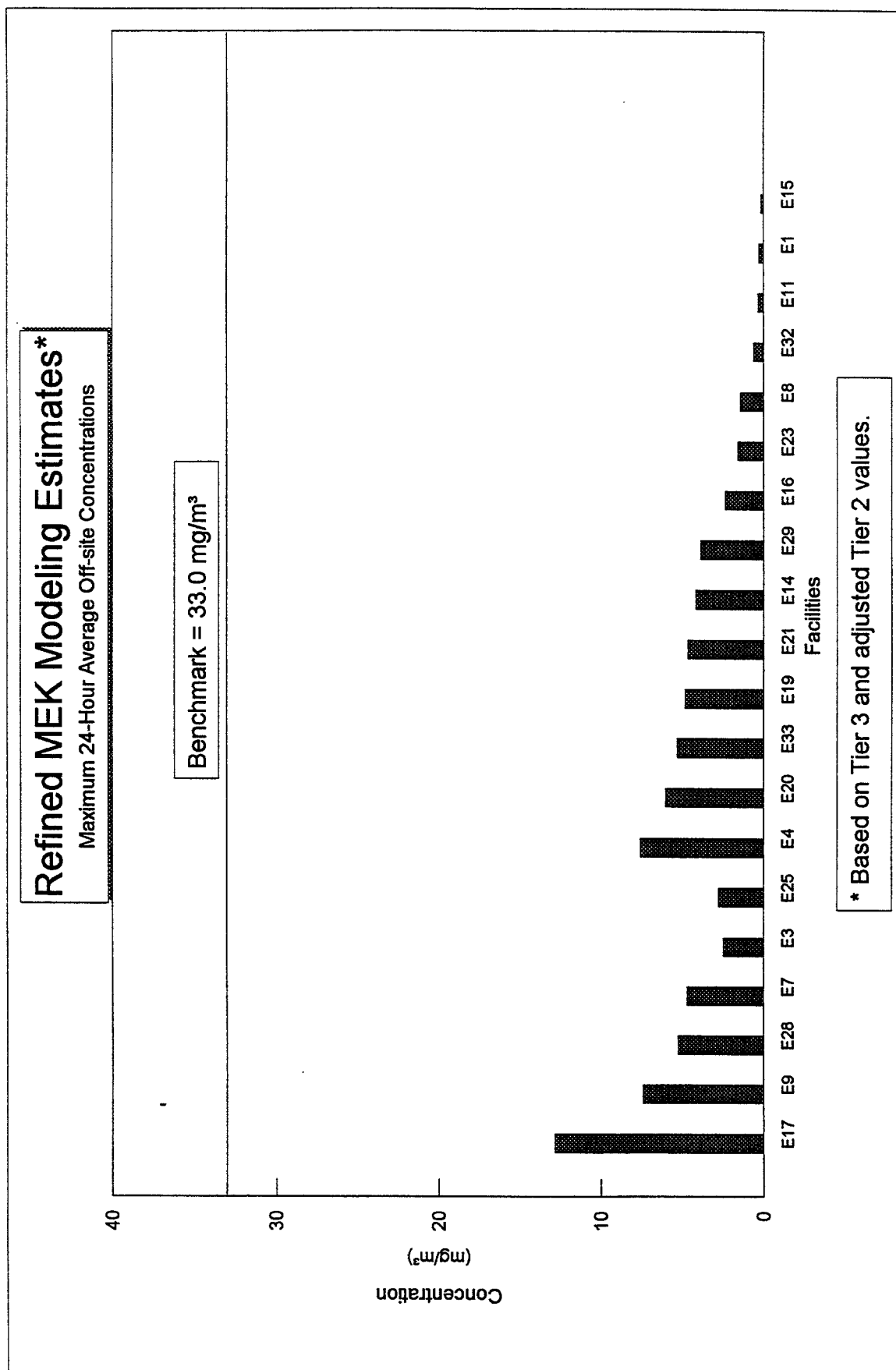E17 E9 E28 E7 E3 E25 E4 E20 E33 E19 E21 E14 E29 E16 E23 E8 E32 E11 E1 E15

5.0 EVALUATION OF LESSER MEK SOURCES

The second part of this study was designed to estimate maximum airborne concentrations in the vicinity of lesser MEK emitting facilities. Because of the large number of facilities reporting more than 10 ton/yr MEK emissions on the TRI (over 2300), it is not feasible to conduct facility-specific modeling for even a significant portion of them. ENSR therefore applied a generalized approach for estimating maximum off-site concentrations from lesser emitting facilities. As noted above in Section 2.2, this generalized approach was also used to estimate maximum annual off-site concentrations for top-emitting facilities for which site-specified information was not obtained.

5.1 Generalized Modeling Approach

ENSR developed a generalized approach for estimating maximum off-site concentrations from smaller facilities with between 10 and 200 tons/yr of MEK emissions according to TRI data. First, the TRI database was used to sort all facilities that reported more than 10 tons of MEK emissions on the 1994 TRI into source categories based on their two-digit SIC codes. SIC codes for which Tier 1, 2, or 3 modeling had already been performed were not considered. A generalized dispersion modeling approach was then used to conservatively estimate the maximum annual average concentrations in the vicinity of sources in each category. The annual MEK emissions for the two facilities with the highest and second-highest emissions in each of the identified SIC codes were used in the assessment.

The U.S. EPA dispersion modeling approach used in support of the proposed 112(g) rulemaking was used in this categorical assessment (EPA, 1993). EPA conducted dispersion modeling using the Human Exposure Model (HEM) to estimate maximum annual concentrations as a function of distance and source height. EPA's modeling assessment conservatively used the following assumptions:

- all facility emissions emanate from a single point source,
- negligible exit velocity (10 cm/sec),
- emitted at ambient temperature,
- source subject to worst-case aerodynamic building downwash.

HEM uses climatological data in the form of a joint frequency distribution of wind speed, wind direction and atmospheric stability. EPA applied HEM using 314 separate climatological data sets based on NWS stations located throughout the United States and a single stack height/receptor distance combination (10 m stack, 200 m receptor). Annual concentrations associated with a 10

ton/yr release varied widely among the 314 data sets with the highest annual concentration (15.6 ug/m^3) being a factor of 3.1 greater than the median concentration (5.0 ug/m^3). EPA then conducted an additional sensitivity analysis, using the median dispersion climatology, to determine how modeled annual concentrations would vary depending upon different combinations of source height and receptor distance. The results of this sensitivity analysis are summarized in Table 4 of the EPA document and provided in Appendix B (EPA, 1993).

For the MEK study, an upper limit concentration has been estimated for various combinations of stack height, and receptor distance by multiplying the EPA Table 4 dispersion coefficients by a factor of 3.1. This approximates the highest annual average concentration that would occur at the location (in the United States) that has the worst dispersion climatology.

This conservative method was used to estimate concentrations at nearby receptors for "model" facilities representing the largest emitters in each of the SIC codes. To simplify the analysis, a model facility (defined in terms of stack height and receptor distance) has been defined for the following three "Dispersion Categories" to which each of the SIC codes is assigned.

Heavy: Major facilities typically located in highly industrialized areas with substantial building dimensions on relatively large sites (stack height = 15 m, receptor = 200 m)

Medium: Moderate size facilities typically located in industrially or commercially zoned areas on medium-sized properties (stack height = 10 m, receptor = 150 m)

Light: Smaller typically one-story facilities with roof vents and limited site acreage located in mixed use areas (stack height = 5 m, receptor = 100 m)

EPA Table 4 dispersion factors (Appendix B) were estimated for each category (using linear interpolation where necessary) and then multiplied by a factor of 3.1 to adjust for worst-case dispersion climatology. This resulted in the following dispersion factors for each category, in units of mg/m^3 per million pounds of MEK emissions:

Light:	4.1
Medium:	0.91
Heavy:	0.39

5.2 Estimated Receptor Concentrations

Table 5-1 provides the applicable SIC codes, representative dispersion category, and corresponding dispersion factor. These dispersion factors were then multiplied by the emission

TABLE 5-1

Maximum Annual Off-site Concentrations at Lesser Emitters*

SIC Code	Description	Dispersion Category	Table 4 Factor (mg/m³ per MMlb)	Annual Emissions of Highest Emitter In SIC Code (lbs)	Max Concentration Based on Highest Emission Rate (mg/m³)	Annual Emissions of 2nd Highest Emitter In SIC Code (lbs)	Max Concentration Based on 2nd Highest Emission Rate (mg/m³)
23	Apparel	L	4.1	179,264	0.735	74,622	0.306
24	Lumber	M	0.91	378,865	0.345	266,162	0.242
25	Furniture	L	4.1	195,801	0.803	136,958	0.562
26	Paper	M	0.91	362,560	0.330	248,158	0.226
27	Printing	M	0.91	185,000	0.168	176,000	0.160
28	Chemical	H	0.39	282,754	0.110	248,158	0.097
31	Leather	L	4.1	112,211	0.460	64,853	0.266
32	Concrete	L	4.1	127,000	0.521	120,007	0.492
45	Air Transportation	M	0.91	24,000	0.022	NA	NA
51	Wholesale Trade	L	4.1	152,800	0.626	113,316	0.465
87	Engineering	L	4.1	24,930	0.102	NA	NA
97	Nat. Security	H	0.39	185,757	0.072	137,627	0.054

* Based on U.S. EPA's 112(g) methodology (EPA, 1993)

rates of the highest and second-highest MEK emitting facilities in each SIC code. As indicated on Table 5-1, the resultant concentration estimates are all below 1 mg/m^3 and well below 1 mg/m^3 in most cases.

The Tier 3 results for the top emitters indicate that maximum 24-hour concentrations are a factor of 4 to 14 times greater than the annual concentrations. If the upper limit annual to 24-hour averaging time adjustment factor of 14 is applied, the highest estimated 24-hour concentration among the SIC code is about 7 mg/m^3, well below the 30 mg/m^3 benchmark.

To verify the validity of this generalized approach, it has also been applied to the SIC codes of the top emitters, for which refined modelling was already conducted. The facility with the maximum emissions represented each SIC code and was modeled using the generalized methodology and the results were then compared with the maximum refined modeled concentration (both Tier 3 and adjusted Tier 2, as illustrated in Figure 4-1) among the sources belonging to that SIC. The results are shown on Table 5-2**. For all SIC codes, the generalized approach predicted higher concentrations than the refined assessment, thus demonstrating that the generalized approach is conservative.

Generalized modeling results for several top MEK emitters provided in Table 4-2 also indicate annual concentrations well below 1 mg/m^3. Given the demonstrated conservatism of the generalized approach, actual off-site impacts are likely to be substantially lower.

**Note that Table 5-2 shows the maximum annual emissions for the top-emitting facility in each SIC code, along with the generic annual off-site concentration estimate for that facility. However, the column labeled "Maximum Refined Concentration (mg/m^3) in SIC Code" is not necessarily the refined modeling result for the same facility. Rather, it represents the highest annual off-site concentration modeled among all facilities in that SIC code, which may or may not correspond to the facility with the highest annual emissions. As noted above, the facilities provided site-specific data for modeling based on conditions of confidentiality, and this approach was necessary to preserve the confidentiality of the refined modeling results.

TABLE 5-2

Evaluation of Top Emitters Using the Generalized EPA Table 4 Approach

SIC Code	Annual Emissions of Highest Emitter In SIC Code (lbs)	Dispersion Category	Table 4 Factor (mg/m³ per MMlb)	Table 4 Estimated Concentration (mg/m³)	Maximum Refined Conc. In SIC Code (mg/m³)	Refined/Estimated Conc. Ratio*
21	609,594	H	0.39	0.24	0.03	0.13
22	2,015,145	M	0.91	1.83	1.18	0.64
29	1,177,560	M	0.91	1.07	0.63	0.59
30	1,525,448	M	0.91	1.39	0.91	0.65
33	694,000	H	0.39	0.27	0.17	0.63
34	578,000	M	0.91	0.53	0.045	0.09
35	626,360	M	0.91	0.57	0.36	0.63
36	1,010,000	M	0.91	0.92	0.31	0.34
37	489,189	H	0.39	0.19	0.025	0.13
38	517,000	M	0.91	0.47	0.39	0.83
39	367,839	L	4.1	1.51	0.81	0.54
* Average Refined/Estimated Concentration Ratio = 0.47						

6.0 COMBINED IMPACTS

The dispersion analyses of both the top-emitting facilities and smaller sources have demonstrated that maximum off-site concentrations at potentially exposed receptor locations are less than about 30% of the annual and 24-hour benchmarks (3.3 mg/m^3 for annual and 33 mg/m^3 for 24-hour). As such, there are no combinations of sources (unless three or more sources are virtually co-located) that could result in receptor concentrations exceeding the health protective benchmarks. Hypothetically, for sources to contribute to off-site receptor concentrations above the RfC, at least 3 major MEK emitters would need to be side-by-side with a receptor located between them. As can be noted from Table 2-2, none of the top MEK emitting facilities are located in the same geographic area.

Although the modeling analysis indicates that combined impacts are highly improbable, an investigation was made to identify clusters of MEK sources to review the potential for combined impacts. As a first step, the 1994 TRI database was used to identify all MEK sources reporting more than 10 tons of MEK emissions in 1994. Of the 800 facilities identified, 709 facilities were the only MEK source within the (5 digit) zip code area. The other 91 facilities are distributed fairly evenly among 37 zip code areas. Of these areas, 34 had total annual MEK emissions of less than 200 tons. One zip code contained as many as 5 facilities, but with combined annual emissions of only about 100 tons. Refined dispersion modeling for top MEK emitters has demonstrated that single facilities emitting 200 tons per year or more result in ambient annual concentrations of less than 1 mg/m^3. For the 34 zip code areas, even if all the facilities in the area were co-located, refined modeling suggests that off-site concentrations are highly unlikely to exceed 1.0 mg/m^3.

One of the remaining 3 zip code areas had one facility among the top 26 emitters of MEK (modeling indicated concentrations in the vicinity are well below benchmark concentrations) and another facility emitting less than 15 tons per year. Because the smaller source represents only about 5% of the total emissions in the area, concentrations would not increase appreciably even if the 2 sources were co-located.

The remaining 2 zip code areas that had multiple sources collectively emitting more than 200 tons were examined according to the following distance criterion. The modeling analyses of the top emitting MEK sources were reviewed to determine the maximum separation distance for two sources to potentially have a combined impact greater than 1.0 mg/m^3. This distance was conservatively estimated by doubling the maximum modeled distance corresponding to an annual concentration of 0.5 mg/m^3. Refined modeling indicates that airborne concentrations fall off

rapidly with distance. Among the 7 top emitting facilities for which Tier 3 modeling was conducted, annual concentrations exceeded this value out to a maximum distance of 175 m (about one tenth of a mile) beyond the facility fenceline. Therefore, a receptor would have to be located between two large MEK emitting facilities, located 350 m (about two tenths of a mile) apart if there is to be a possibility of annual concentrations greater than 1.0 mg/m^3.

The 2 zip code areas evaluated with this criterion each contain two principal sources. Refined modeling has indicated that 2 major sources separated by more than 350 m would avoid significant overlapping impacts. The distance between sources within these 2 zip code areas exceeded this distance. Therefore, it is concluded that combined impacts from multiple sources of MEK will not result in ambient levels greater than either 1.0 mg/m^3 (annual average) or 10 mg/m^3 (24-hour average).

7.0 CONCLUSIONS

A dispersion modeling analysis was conducted to evaluate maximum off-site concentrations of MEK in the vicinity of both large and small sources of MEK emissions. Site specific modeling was performed for 20 of the 26 facilities that reported MEK emissions of 400,000 pounds or more in 1994. The remaining 6 facilities were modeled using a generalized air dispersion modeling approach used by EPA in its CAA Section 112(g) rulemaking.

The same generalized approach was used to estimate maximum off-site concentrations that result from MEK emissions from smaller sources. For this analysis, all facilities that reported more than 10 tons of MEK emissions on the 1994 TRI were divided into source categories based on their two-digit SIC codes. Parameters were developed for each SIC code and the generalized approach was then used to predict likely maximum airborne concentrations based on the emissions rates for the highest and second-highest emitting facilities in each SIC code.

In evaluating this study, it is important to recognize that the modeling results are intended to represent maximum off-site concentrations (averaged over one year or 24 hours) and are not intended to represent actual human exposures. For each of the top-emitting facilities, the location of the maximum modeled concentration was at or near the facility fenceline, where there are unlikely to be continuous exposures for more than a few hours a day. On the other hand, the health benchmarks used in this study are designed to be protective for continuous exposures. In addition, the modeling itself (even Tier 3 analysis) incorporates certain assumptions that are relatively conservative. Actual off-site concentrations are likely to be lower than maximum modeled concentrations, and actual exposures are likely to be much lower.

The modeling study demonstrates that (1) maximum annual off-site concentrations of MEK are expected to be less than 1 mg/m^3 in all cases, and well below $1/mg/m^3$ in most cases; and (2) maximum 24-hour off-site concentrations of MEK are expected to be less than 10 mg/m^3 in all cases, and well below $10/mg/m^3$ in most cases. The one exception is a major emitter for which the maximum annual off-site concentration was 1.18 mg/m^3 and the maximum 24-hour concentration was 12.82 mg/m^3. At this facility, however, there were no receptors near the point of the highest predicted concentrations.

Finally, there is no group of MEK emitting facilities that collectively would result in maximum off-site concentrations greater than 1 mg/m^3 (annual average) or 10 g/m^3 (24-hour average).

REFERENCES

EPA, 1992. A Tiered Modeling Approach for Assessing the Risks Due to Sources of Hazardous Air Pollutants. EPA-450/4-92-001. U.S. Environmental Protection Agency, Research Tringale Park, NC.

EPA 1992a. Screening Procedures for Estimating the Air Quality Impact of Stationary Sources, (Revised). EPA 454/R-92-019. U.S. Environmental Protection Agency, Research Triangle Park, NC.

EPA, 1993. Documentation for DeMinimis Emission Rates for Proposed 40 CFR Part 63, Subpart B (EPA-453/R-93-035).

EPA, 1995. Guideline on Air Quality Models (Revised). EPA-450/2-78-027R, including Supplements A, B and C. U.S. Environmental Protection Agency, Research Triangle Park, NC.

APPENDIX A

DATA REQUEST FORMS

CHEMICAL MANUFACTURERS ASSOCIATION
KETONE PANEL

Data Request for Air Quality Modeling

Your Name and Title:_____

Your Company's Name:_____

Your Voice Phone Number:_____Your FAX Number:_____

Please complete Parts I, II, and III for your facility.

Part I - General Facility Information

Please provide the following information for your facility:

1.   A plot plan of the facility showing the property boundary, fenceline, source locations (by source names), building locations, and building heights (Hb) above ground level. Include significant storage tank locations and heights.

hints.....

- Multiple tiered buildings, Hb = height above ground of each tier

- Peaked roof, Hb = ground to the highest point of the roof

- Outdoor process equipment -
  - May disturb the wind like a building
  - Approximate the area of this equipment on the plot plan
  - Hb = height that would represent about 90% of the process equipment area.

2.   A U.S.G.S. topographic map of the area, showing the location of the facility,
                                        or
UTM coordinates or latitude and longitude, and average ground-level elevation.

Part II - Point Source Information

Please complete Table 1 for your facility.

        Large number of (nearly) identical sources? List one representative source plus a footnote indicating the number of such sources and their identification numbers which cross-reference their location on the plot plan.

        Only know the total emissions for a group of sources? Do they have very similar release characteristics? If yes, list a representative source, number of sources, and identification for the plot plan.

Part III - Fugitive Emissions Inventory

Please complete Table 2 for the sources of fugitive emissions at your facility.

POINT SOURCE DATA
FOR AIR QUALITY MODELING OF MEK EMISSIONS

	Source #	Source #	Source #	Source #	Source #
1. Source Name or Identification Number					
2. Total Amount of MEK Emitted from Source in 1994 (lbs)					
3. Maximum Amount of MEK Emitted from Source Hourly (lbs)					
4. Temperature of Emissions (°F)					
5. Height of Emissions at Release Point (feet)					
6. Diameter of Opening thru Which Emission Escapes (feet)					
7a. Total Volumetric Flow Rate (ACFM) OR					
7b. Flow Exit Velocity (feet/minute)					
8. Is Emission Directed Straight Up, Unimpeded Into Atmosphere (Y/N)?					

Notes:

(1) Enter any descriptive name, i.e. "Vent 123", "Dryer Stack", etc.
(2) Contact CMA if significant changes in emissions have or are expected to occur since 1994.
(6) If vent is rectangular, enter diameter of a circle of equivalent area.
(7a) ACFM = actual cubic feet per minute (calculated using density of the vapor at the temperature of the release).
(8) If stack has "rain hat", or release is directed in the horizontal direction or toward the ground, then you must answer "no".

Questions? Contact Barbara Francis with CMA at (202) 887-1314.

FUGITIVE SOURCE DATA
FOR AIR QUALITY MODELING OF MEK EMISSIONS

	Source # ___	Source # ___	Source # ___	Source # ___	Source # ___
1. Source Name or Identification Number					
2. Total Amount of MEK Emitted from Source in 1994 (lbs)					
3. Maximum Amount of MEK Emitted from Source Hourly (lbs)					
6. Type of Fugitive Emission: A,B, or C (see drawings below)					
7. Cross Sectional Area Associated with Fugitive Emissions (ft²)					
8. Characteristic Height Associated with Fugitive Emission (feet)					

Notes:

(1) Enter any descriptive name, i.e. "Fugitives From ABC Unit", "Waste Water Treatment Pond", etc.

(2) Contact CMA if significant changes in emissions have or are expected to occur since 1994.

(6) Type "C" is useful for describing fugitive emissions from chemical processing units, pipe racks, or pump alleys in which the chemical of interest escapes through leaking valves and flanges scattered throughout some "imaginary" volume which surrounds the unit.

(7) Emission area is shown as rectangular in drawings, but other shapes are also valid; shape does not matter -- so long as cross sectional area specified (in square feet) is correct.

Questions? Contact Barbara Francis with CMA at (202) 887-1314.

APPENDIX B

**TABLE 4 OF THE 112(g) PROPOSED
RULEMAKING SUPPORT DOCUMENT**

Table 4. Sensitivity of ambient fence-line concentration to

stack height and fence-line distance for the "Model" Plant

Stack height (meters)	Distance to nearest residence (meters)	Median concentration ($\mu g/m^3$)
1	200	16
3	100	34
3	500	3.4
10	100	6.7
10	200	5.0 *
10	500	2.8
15	200	2.5
50	200	0.15
100	200	0.026

* These parameters are assumed in the model plant used to
calculate emission rates for the proposed rule

Note: The model plant has:

       Emission Rate = 10 tons per year;
       Stack Hieght = 10 meters;
       Stack Diameter = 1 meter;
       Exit Velocity = 0.1 meters / second;
       Stack Temperature = 295 Kelvin (ambient)
       Distance to Nearest exposed individual = 200 meters;
       Worst case down-wash.

APPENDIX J

MEK EMISSIONS BY ZIP CODE

MEK EMISSIONS BY ZIP CODE

For the year 1994, there were 800 facilities that reported MEK releases to air of 20,000 pounds (10 tons) or more, including both point and non-point emissions. Of this number, 709 facilities were located in ZIP codes in which there was no other facility reporting MEK emissions greater than 20,000 pounds during the year.

The following chart shows the remaining 91 facilities. It is organized to show the MEK emissions by ZIP code for each ZIP code in which there were multiple facilities reporting MEK emissions greater than 20,000 pounds in 1994. All data is from the 1994 Toxics Release Inventory.

LOCATION BY ZIP CODE	FACILITY NAME	TOTAL AIR RELEASE
07095	Gentek Building Prods.	26,627
Middlesex, NJ	Russell-Stanley Corp.	36,623
	Total Air Release for Zip Code:	**63,250**
17402	York Casket Co.	28,700
York, PA	Harley-Davidson Motor Co.	20,250
	Total Air Release for Zip Code:	**48,950**
17847 Milton, PA	ACF Ind. Inc.	28,740
Northumberland, PA	Resilite Sports Prods. Inc.	648,757
	Total Air Release For Zip Code:	**677,497**
19154	Allied Lube & Conduit Corp.	130,185
Philadelphia, PA	Kurz-Hastings, Inc.	376,000
	Total Air Release For Zip Code:	**506,185**
24012	Tread Corp.	25,200
Roanoke, VA	Singer Furn. Co. Roan Plant	21,375
	Total Air Release For Zip Code:	**46,575**
24055	JD Bassett Mfg. Co.	25,503
Bassett, VA	Bassett Superior Lines	92,862
	Bassett Table Co.	57,739
	Bassett Mirror Co. Philpott Plant	24,050
	Total Air Release For Zip Code:	**200,154**
24112	American Furniture Co. Inc.	50,852
Martinsville, VA	W.M. Bassett Furniture Co.	34,757
	Total Air Release For Zip Code:	**85,609**

24311	Merillat Ind. Inc.	40,104
Atkins, VA	Virginia House Furniture Corp. Plant 1	25,300
	Virginia House Furniture Corp. Plant 2	26,300
	Total Air Release For Zip Code:	**91,704**
24333	EC Dodson Plant	36,463
Galax, VA	TG Vaughn Plant	50,220
	BC Vaughn Plant	34,238
	Vaughn-Bassett Furniture Co.	67,467
	Webb Furn. Ents. Inc. Plant 1	22,800
	Total Air Release For Zip Code:	**211,188**
24354	Marley Mouldings Inc.	39,755
Marion, VA	Marion Composites	71,950
	Total Air Release For Zip Code:	**111,705**
27261	Lilly Ind. Inc.	27,720
HighPoint, NC	Marsh Furniture Co.	37,052
	AKZO Nobel Coatings, Inc.	23,957
	Total Air Release For Zip Code:	**88,729**
27292	TI Industries	117,542
Lexington, NC	Lexington Furniture Ind. Plant 4&5	22,900
	Lexington Furniture Ind. Plant 7	57,664
	Lexington Furniture Ind. Plant 12	33,834
	Total Air Release For Zip Code:	**174,276**
28043	Crellin Inc.	50,000
Forest City, NC	AG Ind. Inc.	44,250
	Total Air Release For Zip Code:	**94,250**
28139	Broyhill Furniture Ind. Inc.	50,816
Rutherfordton, NC	Reeves Intl. Grace Plant	30,135
	Total Air Release For Zip Code:	**109,090**
28601	Century Furn. Ind. Plant 1	20,517
Hickory, NC	Hickory White Co. Casegoods Div.	31,246
	Siecor Telecom. Cable Plant	42,365
	Total Air Release For Zip Code:	**94,128**
28613	Decor Originals Inc.	25,062
Conover, NC	Lackawanna Leather Co.	112,211
	Total Air Release For Zip Code:	**137,273**

28633 Lenoir, NC	Broyhill Furn. Ind. Inc. Complex	195,801
	Broyhill Furn. Inc. Inc. Lenoir	64,751
	Total Air Release For Zip Code:	**260,552**
28645 Lenoir, NC	Paxar Printed Label Group	179,264
	Singer Furniture Co.	95,391
	Thomasville Furniture Ind.	40,200
	Broyhill Furniture Ind. Inc. Harper	55,402
	Total Air Release For Zip Code:	**370,257**
28704 Arden, NC	Crown Cork & Seal Co. Inc.	23,700
	Day International	35,818
	Phillips Consumer Electronics Co.	83,560
	Total Air Release For Zip Code:	**143,078**
28777 Spruce Pine, NC	Ethan Allen Inc. Spruce Pine Div.	20,436
	Henredon Furniture Ind. Inc.	32,897
	Total Air Release For Zip Code:	**53,333**
29150 Sumter, SC	Korn Ind. Inc.	136,004
	Vaugh-Bassett/Williams Furn. Co. Inc.	28,169
	Total Air Release For Zip Code:	**164,173**
29202 Columbia, SC	Kline Iron & Steel Co. Inc.	26,000
	Consolidated Systems Inc.	41,100
	Total Air Release For Zip Code:	**67,100**
29605 Greenville, SC	Lockheed Aeromond Centers Inc.	26,750
	Crown Metro Inc.	20,455
	Total Air Release For Zip Code:	**47,205**
31709 Americus, GA	Woodgrain Millwork Inc.	378,865
	Textron Automobile Exteriors	489,189
	Total Air Release For Zip Code:	**868,054**
37303 Athens, TN	P-I Inc.	31,700
	Athens Furniture Ind. Inc. Bed Plant	20,660
	Textron Automobile Interiors	126,400
	Total Air Release For Zip Code:	**178,760**
37814 Morristown, TN Camelot, TN	Lea Ind. Plant #4	23,333
	Universal Bedroom Furniture Ltd.	53,850
	Rexam Metallising	95,441
	Pollyfibron Techs. Inc.	29,500
	Total Air Release For Zip Code:	**202,124**

38464, Ripley, TN	Tennessee Electroplating Inc.	34,906
Lawrenceburg, TN	Murray Ohio Mfg. Co.	25,600
	Total Air Release For Zip Code:	**60,506**
44805	National Latex Prods Co.	33,331
Ashland, OH	Hedstrom Prods Co.	112,112
	Total Air Release For Zip Code:	**145,443**
46041	Crellin Inc.	90,343
Frankfort, IN	Federal Mogul Corp.	36,950
	Total Air Release For Zip Code:	**127,293**
47201	Arvin Ind. Inc. NAA Div. 17th St.	47,400
Columbus, IN	Toyota Indl. Equipment Mfg. Inc.	26,685
	Total Air Release For Zip Code:	**74,085**
47546	Aristokraft Inc. Plant 2	22,250
Jasper, IN	Aristokraft Plant 3	20,250
	Total Air Release For Zip Code:	**42,500**
49508, Grand Rapids, MI	Steelcase Inc.	97,408
Kentwood, MI	Steelcase Inc.	226,670
	Total Air Release For Zip Code:	**324,078**
49512	Lacks Ind. Inc. Raleigh Plant	110,550
Kentwood, MI	Plastics Plate Inc. Plant 2	61,100
	Total Air Release For Zip Code:	**171,650**
60007	Clear Lam Packaging	25,162
Elk Grove Village, IL	Pre-Finish Metals Inc.	69,165
	Pre Finish Metals Inc.	22039
	Total Air Release For Zip Code:	**116,366**
70058	Sigma Coatings USA B.V.	28,024
Harvey, LA	Evans Contianer Corp.	35,986
	Total Air Release For Zip Code:	**64,010**
70805	Exxon Co. USA Baton Rouge Refg.	152,800
Baton Rouge, LA	Exxon Chemical Baton Rouge Chemical	34,724
	Total Air Release For Zip Code:	**187,524**
98055	Kenworth Truck Co.	26,200
Renton, WA	Boeing Commercial Airplane Group	167,000
	Total Air Release For Zip Code:	**193,200**